MARYLAND GEOLOGICAL SURVEY

MIDDLE AND UPPER DEVONIAN

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LETTER OF TRANSMITTAL

To His Excellency PHILLIPS LEE GOLDSBOROUGH,

Governor of Maryland and President of the Geological Survey Commission,

Sir:—I have the honor to present herewith the sixth volume of a series of reports dealing with the systematic geology and paleontology of Maryland. The preceding volumes have dealt with the Lower Devonian, Lower Cretaceous, Eocene, Miocene, and Pliocene and Pleistocene deposits and the remains of animal and plant life which they contain. The present volume treats of the Middle and Upper Devonian deposits and their contained life, a knowledge of which is very important from an educational and scientific standpoint. I am,

Very respectfully,

WM. BULLOCK CLARK,

State Geologist.

JOHNS HOPKINS UNIVERSITY,

BALTIMORE, *January*, 1913.

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ILLUSTRATIONS

PREFACE

The present volume is the sixth of a series of reports dealing with the systematic geology and paleontology of Maryland, the Lower Devonian, Lower Cretaceous, Eocene, Miocene, and Pliocene and Pleistocene deposits having already been fully described.

The present volume is devoted to a consideration of the Middle and Upper Devonian deposits and their contained faunas, the Lower Devonian geology and its life having been fully treated in a companion volume devoted to that subject.

The discussion of the Middle and Upper Devonian is the combined result of the work of a number of individuals, many of them experts in special fields of research.

The general stratigraphic description of the Middle and Upper Devonian has been the work of Prof. Charles S. Prosser, of Ohio State University, who has also contributed the discussion of the faunas of the Middle Devonian.

The Upper Devonian faunas are described by Dr. John M. Clarke, Director of New York Geological Survey, and Dr. Charles K. Swartz, of the Johns Hopkins University. Dr. Edward M. Kindle, formerly of the U. S. Geological Survey, has contributed a chapter on the stratigraphy and fauna of the Onondaga horizon of the Middle Devonian.

The limited Bryozoan and Ostracod faunas are contributed, as in previous volumes, by Drs. E. O. Ulrich and R. S. Bassler, of the U. S. Geological Survey and U. S. National Museum respectively.

Dr. C. K. Swartz, of the Johns Hopkins University, has furnished a chapter on the correlation of the Onondaga and Marcellus members of the Romney formation, and has contributed a large amount of material for the stratigraphic and paleontologic chapters.

The Maryland Geological Survey has enjoyed the cooperation of the U. S. Geological Survey as in previous volumes. It is indebted to this organization for the use of drawings illustrating Dr. Kindle's contribution. Special acknowledgment is due to Dr. John M. Clarke for the loan of many drawings first used in the classic volumes of the New York Geological Survey.

THE MIDDLE DEVONIAN DEPOSITS OF MARYLAND

BY

CHARLES S. PROSSER

EDWARD M. KINDLE

AND

CHARLES K. SWARTZ

THE MIDDLE DEVONIAN DEPOSITS OF MARYLAND

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CHARLES S. PROSSER, E. M. KINDLE, AND C. K. SWARTZ

INTRODUCTORY[1]

The Paleozoic time divisions—Cambrian, Ordovician, Silurian, Devonian, Carboniferous and Permian—which are called *periods* by the International Congress of Geologists and the United States Geological Survey and *eras* in Dana's Manual of Geology[2] were frequently divided in a general way into lower, middle, and upper divisions while the terms earlier and later were sometimes used. In 1894, Prof. Henry S. Williams proposed that this two- or three-fold division should be designated by prefixing the syllables *Eo* (dawn), *Meso* (middle), and *Neo* (new) to the name of the period.[3] Later, the syllable *Paleo* (ancient), has been substituted by some authors for *Eo*.[4] The Devonian formations were distributed by Professor Williams under these three divisions in the following manner: The *Eodevonian* contained the Oriskany sandstone, Cauda galli (Esopus) and Schoharie grits and Corniferous or Onondaga

[1] Contributed by Charles S. Prosser.

[2] In general the taxonomic terms of the International Congress of Geologists will be used in this report. Frequently, however, the term *beds* is used instead of *stage*, as Hamilton, Portage, or Chemung beds, a term of similar taxonomic value used by Messrs. Clarke and Schuchert in their descriptions of certain New York formations.

[3] Jour. Geology, Vol. II, p. 157, and see table on p. 155.

[4] Clarke and Schuchert, Science, N. S., Vol. X, Dec. 15, 1899, p. 876; and Am. Geologist, Vol. XXV, 1900, p. 118.

The International Congress of Geologists at the Paris meeting of 1900 adopted the prefix *Paleo*, but stated that *Eo* may be used to shorten too long a name (Comptes Rendus, 8th Session, 1901, pp. 153, 198).

limestone; the ***Mesodevonian,*** the Marcellus shale and Hamilton formation, and the ***Neodevonian*** the Tully limestone, Genesee shale, Portage and Chemung formations together with the Catskill formation which in eastern New York and northeastern Pennsylvania replaces the greater part of the Chemung and Portage formations.

Recently Dr. J. M. Clarke and Prof. Charles Schuchert have transferred the Lower Helderberg to the Devonian and rearranged the list of formations for the Lower Devonian and Middle Devonian. In their classification the Lower Devonian consists of the Lower Helderberg limestones or Helderberg and the Oriskany sandstone; while the Esopus and Schoharie grits and Onondaga limestone were referred to the Middle Devonian.[1]

GENERAL DISTRIBUTION

Rocks of Middle Devonian age have a considerable distribution, aside from that of the eastern United States and Canada, for they have been identified and described in Nevada; the dolomite of Manitoba contains the European species *Stringocephalus burtini; Spirifer mucronatus* has been found upon the banks of the Albany River south of Hudson Bay; the fauna of the Hamilton shales occurs in the Mackenzie Valley from the Clear Water River to the Arctic Ocean, while it is also reported from the Porcupine River, a western tributary of the Yukon in Alaska and perhaps also on Kouiou Island in the southern part of that territory. In the Brazilian province of Para, in the Ereré district, are beds which Katzer refers to the base of the Middle Devonian. Dr. John M. Clarke has stated regarding the fauna of the Ereré sandstone that it "is remarkably free from species or representatives of subgeneric groups prevailing elsewhere in early Devonian faunas and equally devoid of types which elsewhere pass upward into the later faunas; in other words, it is with all its resemblance to the Hamilton, a more typical and better defined Middle Devonian fauna than that."[2]

[1] Science, N. S., Vol. X, 1899, p. 876.

[2] Archivos do Museu Nacional do Rio de Janeiro, Vol. 10, 1899. Author's English edition, 1900, p. 90.

Later Prof. Schuchert reviewed the works on the "Geology of the lower Amazon region" and stated that the Ereré fauna "seems to hold the horizon of the American Onondaga, hardly that of the Hamilton, and certainly there is nothing in it that indicates the Genesee fauna."[1]

Dr. Steinmann reported Middle Devonian from Bolivia, east of Lake Titicaca,[2] which is also accepted by Dr. Frech, and Prof. Cleland from the Jachel River in Central Argentina.[3]

On the Eastern Continent Middle Devonian rocks occur in England in northern and southern Devonshire, in northern France and southern Belgium, in the region of the Vosges, the Central Plateau and the Montagne-Noire of France, in the Pyrenees and Spain. In central and eastern Europe they occur in the Eifel, Rheinland (Nassau), Hartz, Thuringia, Bohemia, Galicia, Russian Poland, the Carnic Alps and on the Bosphorus. These rocks also cover a large area of eastern Russia and the western slope of the Urals extending to the border of Finland on the north. In Asia Middle Devonian rocks occur in Armenia, Siberia, China and on the south side of the Tian-Shan Mountains in Central Asia. In Australasia in New South Wales, Victoria and Tasmania and also in Africa in the Sahara.[4]

EUROPEAN EQUIVALENTS

The early attempts at correlating the Devonian rocks of the United States with those of Europe dealt only with the formations found in New York which in fact has generally been the custom down to the present time. In 1842 Conrad published the statement that "the Ithaca group, Chemung group, and the Old Red Sandstone near Blossburg, in Pennsyl-

[1] Jour. Geol., Vol. XIV, 1906, p. 738. Also see p. 734 where Schuchert states that "while he would refer it [the Ereré fauna] to a horizon about that of the Onondaga (Corniferous), he holds that it has no close faunistic relationship with it."

[2] Am. Nat., Vol. 25, p. 856.

[3] Bull. U. S. Geol. Surv., No. 206, 1903, p. 19.

[4] For this account of the distribution of the Middle Devonian the writer is largely indebted to de Lapparent's Traité de Géologie, Frech's Lethaea palaeozoica and Kayser's Lehrbuch der geologischen Formationskunde.

vania, constitute the equivalents of the Devonian system as developed in Europe" and contain a number of fossils characteristic of European Devonian strata.[1] The same year Vanuxem stated that the last three groups of the "Erie Division," viz., the Portage, Ithaca and Chemung "appear to correspond with the Devonian system of Mr. Phillips."[2] The following year Prof. Hall gave the base as somewhat lower when he stated that the Devonian system appears "to correspond to the Chemung and Portage groups, and also to include a portion of the Hamilton."[3] In 1847 Professor Hall stated that "With the Schoharie grit, commences a series of strata containing fossils as distinct from those of the preceding formations, as these are from the lower division. We here, for the first time, recognize several species that are regarded as Devonian forms; and if zoological characters are to be paramount, we are compelled to unite all the succeeding strata as of Devonian age."[4] Finally, in 1859, he raised the question whether even the Oriskany sandstone might not be considered as of Devonian age. For he wrote as follows concerning "the line of demarcation for the Silurian and Devonian systems. Shall the advent of the Oriskany sandstone, with its *Spirifer* of dichotomizing costæ, be the division? Or shall we look for some more marked and more readily defined and recognized feature for the distinction between what are regarded as two great geological systems?"[5]

So far as the writer is aware de Verneuil, in 1847, was the first geologist to definitely correlate the younger formations of the New York System with subdivisions of the Devonian system of Europe. He made the base of the Oriskany sandstone the dividing line between the Devonian and Silurian systems;[6] correlated the Hamilton, Tully, Genesee, Portage and Chemung with the formations of the Eifel and Devonshire, and the

[1] Jour. Acad. Nat. Sci., Philadelphia, Vol. VIII, p. 232.

[2] Geology New York, Pt. III, p. 171.

[3] *Ibid.*, Pt. IV, p. 20.

[4] Palæontology of New York, Vol. I, p. xvii.

[5] *Ibid.*, Vol. III, Pt. I, p. 42.

[6] Bulletin Société Géologique de France, 2d ser., Vol. IV, p. 677; also Am. Jour. Science, 2d ser., Vol. V, 1848, p. 367. On the parallelism of the Palæozoic deposits of North America with those of Europe, translated by James Hall.

Marcellus with the shales of Wissenbach in Nassau, as is proved by their Goniatites, so analogous in form.[1]

In recent years several geologists have considered the correlation of the American Middle Devonian with European rocks of equivalent age, of which the following are the most important.

In 1889 Prof. H. S. Williams apparently correlated in a general way the American Middle Devonian with "the Ilfracombe [England] beds of Phillips, the Givetian limestone of Belgium, [and] the Stringocephalien shales or limestones of the Eifel and Hartz regions."[2] In 1888 Prof. Williams examined in the field typical sections of the Devonian rocks of Devonshire, England, and later stated that "It appears probable that the limestones of South Devonshire represent the general interval between the close of our Corniferous [Onondaga] and the early part of our Chemung formations."[3] Professor Renevier, in 1896, classed the Hamilton flags and Marcellus shales together and regarded them as having been deposited during the same general period of time as the *Tentaculite* slates (lower part) of Thuringia, Hesse, Nassau, and Bohemia; the Wissenbach or *Orthoceras* slates of Nassau; the Lenne slates (in part) of southern Westphalia and the schists with *Phacops potieri* of Brittany; all of which were correlated with the Couvinian age or stage, which he gave as the lower one of the Middle Devonian or Eifelian epoch or series.[4]

Dr. Frech draws the line between the Lower Devonian and the Middle Devonian of New York at the top of the Upper Oriskany sandstone and considers the Middle Devonian as composed of the Ulsterian and Erian series, in the latter of which are the Marcellus shales, Hamilton beds and *Stringocephalus* beds of Canada.[5] At an earlier date Dr. Frech in his summary of the important occurrences of the Devonian gave the

[1] *Ibid.*, p. 678; and Am. Jour. Sci., *ibid.*, pp. 367, 368.

[2] Congrès Géologique International. Compte Rendu, 4me. session, Londres, 1888, 1891. Appendix A, p. 142. Also issued as: Report of the Sub-Committee on the Upper Paleozoic (Devonic) by H. S. Williams, C, 1889, p. 22.

[3] Am. Jour. Sci., 3d ser., Vol. XXXIX, 1890, p. 36.

[4] Chronographe géologique. 2de édit. des Tableaux des Terrains sédimentaires. Compte-rendu du Congrès Géologique International, Sixième session, Août, 1894, Zurich; Lausanne, Mars, 1897.

[5] Lethæa geognostica, I Th. Lethæa palæozoica, 2 Bd., 4 Lief., 1902, p. 690.

Marcellus shale and Hamilton group as forming the upper part of the Middle Devonian and correlated them as beginning in the time of the upper part of the *Calceola sandalina* stage and continuing through that of the *Stringocephalus burtini* of Rheinland.[1] In this same table the Marcellus and Hamilton considered together are correlated with the upper part of the Eifelian (*Calceola* shales of Couvin) together with the entire Givetian (which is composed in ascending order of the red sandstone and conglomerate of Vicht and *Stringocephalus* limestone of Givet) of Belgium. While they are given as equivalent in England to the Ilfracombe beds, with probably additional ones below and above, of North Devon; and to the upper part of the *Calceola* shales of Hope's Nose and Ogwell House succeeded by the diabase and scale stone of the Ashprington series and the *Stringocephalus* limestone of South Devon.

In another part of the work Dr. Frech in comparing the North American and Rhenish Devonian said: In the Corniferous [Onondaga] limestone the faunal diversity is less sharply defined than in the lower formations; but in this case as in the higher Hamilton group still distinctly perceptible. The latter is often developed in the form of sandy marl and calcareous sand and the peculiar faunal similarity with the Rhenish Lower Devonian partly rests upon this harmony in facies. But on the other hand, the marl (Moscow shale), for example, where it forms on Cayuga Lake the greater part of the Hamilton, has a perfect agreement in facies with the *Calceola* marl and likewise the Encrinal limestone reminds one of a similar interstratified limestone. . . . . The fauna of the American Middle Devonian, whose chief representatives the Hamilton group contains, is notwithstanding some corresponding features yet on the whole so different, that one must assume the existence of a special sea province also in Middle Devonian time differing from the Rhenish.[2] . . . . Finally at the close of this section is the statement that the Marcellus shale corresponds to the lower part of the stage of the *Maeneceras terebratum*[3] of Rheinland which Dr. Frech puts in the stage of the *Stringocephalus burtini*.

[1] *Ibid.*, 2 Bd., 1 Lief., 1897, Tab. XIX, op. p. 256.
[2] *Ibid.*, pp. 214, 215.
[3] *Ibid.*, p. 216.

De Lapparent considered the Middle Devonian of North America as composed of the Corniferous (Onondaga) limestone, Marcellus shale and Hamilton beds.[1] The Marcellus shale he correlated with the upper part of the Eifelian stage and lower part of the Givetian while the Hamilton beds represent the remaining and greater part of the latter stage. He also gave the lower Marcellus shale as representing the upper part of the shales of Ogwell House and then the remaining portion together with the Hamilton beds as synchronous with the Ilfracombe or Plymouth beds of Devonshire, England.[2]

Professor Kayser in the table of the Devonian formations of New York in the second edition of his Formationskunde gave the Middle Devonian as composed of the Marcellus shale and Hamilton beds;[3] but in the text he said: The American geologists generally still classify the Onondaga limestone as Lower Devonian; according to European experience one would rather be inclined to classify it entirely or mostly as Middle Devonian. The great similarity of the characteristic *Spirifer acuminatus* with our *S. cultrijugatus* argues for this classification.[4]

Regarding the classification of the Hamilton he wrote: Although the Hamilton shale locally might represent the entire Middle Devonian yet on the whole it corresponds to the upper division. This is surely shown by the frequent overlying beds of the Tully limestone and Genesee shale, the first of which contains the Brachiopod fauna of our Iberg limestone (*Rhynchonella venustula-cuboides*, etc.).[5]

The third edition of this standard reference work, however, gives the Middle Devonian as composed of the Schoharie grit, Onondaga limestone, Marcellus shale and Hamilton beds[6] which differs from the classification of the Middle Devonian of New York by Clarke in the exclusion of the Esopus grit.

[1] Traité Géol., 4th ed., 1900, p. 857.
[2] *Ibid.*, p. 869.
[3] Lehr. d. geol. Formationskunde, 1902, p. 150.
[4] *Ibid.*, p. 151.
[5] *Ibid.*, p. 151.
[6] *Ibid.*, 1908, p. 172.

Finally Kayser has given the correlation of the Middle Devonian of Europe and North America in the following table:

Rheinland	*Belgium*	*Bohemia*	*North America*
Stringocephalus limestone,	Wissenbach and	H	Hamilton beds
		G^3 G^2 G^1 and	Marcellus beds
Calceola shales	Lenne slates	Muenian limestone	Onondaga limestone and Schoharie sandstone [1]

Dr. Hermann Credner gives the Middle Devonian of New York as composed in ascending order of the Upper Helderberg (Onondaga), Marcellus shale and Hamilton sandstone, shale and limestone. The Upper Helderberg he correlates with the Eifelian and stage of the *Calceola sandalina* and the Marcellus and Hamilton with the Givetian and stage of the *Stringocephalus burtini*.[2]

Sir Archibald Geikie considers the Middle Devonian of New York as composed of the Marcellus and Hamilton groups;[3] while the same division in Europe he gives as composed of the Eifelian and Givetian with which he correlates the Marcellus and Hamilton.[4]

DEVELOPMENT OF THE CLASSIFICATION IN NEW YORK

The Geological Survey of New York was organized in 1836 and the annual reports contained the preliminary names of the formations which now compose the Devonian and other systems of rocks represented in that state.[5]

The correlation for the different districts, however, had been more fully perfected when the final reports were published and in these we find, substantially, the list of names which have become classic in the Paleozoic geology of North America. Dr. Emmons' report on the Second District, which covered northeastern New York, was published in

[1] *Ibid.*, p. 179.

[2] Elemente d. Geologie, 9th ed., 1902, p. 447.

[3] Text-Book of Geology, 4th ed., Vol. II, 1903, p. 997.

[4] *Ibid.*, "The Geological Record," opposite p. 861.

[5] See especially the 3d and 4th An. Repts., Fourth Geol. Dist. (Assembly Doc. No. 275, 1839, and *ibid.*, No. 50, 1840), and 4th An. Rept., Third Geol. Dist. (Assembly Doc. No. 50, 1840).

1842 and the name "New York Transition System" was used for the "series which fill up the space between the Primary and the Old Red System."[1] This system was divided by Dr. Emmons into four groups which, arranged in ascending order, he characterized as follows: "Champlain group, at the base of the Transition system; Ontario group, comprehending the rocks which lie upon its southern border for about 15 or 20 miles; the Helderberg series; and lastly, the Erie group, which completes the whole series of the system, extending up to the old red sandstone."[2] The limits of these groups are not clearly indicated in this part of the report; but it appears probable that the upper limit of the Helderberg group was placed at the top of the Upper Helderberg or Onondaga limestone and that the Erie group included the rocks from the base of the Marcellus shales to the top of the Chemung. At the close of the report is given a "Tabular view of the sedimentary rocks of New York"[3] in which appears the "New York system" composed of the four groups named in the earlier part of the report, while the limits of the Helderberg and Erie groups are clearly shown to be as above stated.

The Devonian rocks of New York, however, are most typically developed in the central and western parts of the state which formed the Third and Fourth Geological Districts. The final report of the Third District by Lardner Vanuxem, which covered central New York, also appeared in 1842 and in this the classification of Dr. Emmons, though somewhat modified, was adopted.[4] All the sedimentary rocks of the district, with the exception of the Quaternary and some beds referred to the Taconic system, were given under the "New York System" which was composed of five divisions named in ascending order the Champlain, Ontario, Helderberg, Erie, and Catskill. The Helderberg division included all the rocks from the base of the "Onondaga salt group" to the top of the "Corniferous limestone"; while the Erie division contained the Marcellus

[1] Geology New York, Pt. II, p. 99.

[2] *Ibid.*, p. 100.

[3] *Ibid.*, p. 429.

[4] Vanuxem's statement regarding the general classification of the New York rocks is that "the views of Dr. Emmons were cordially embraced and adopted with some modifications" (Geology of New York, Pt. III, p. 12).

shales, Hamilton group, Tully limestone, Genesee slate, Portage, Ithaca and Chemung groups,[1] thus including all the stages of the Middle Devonian and Upper Devonian of Maryland with the exception of the Catskill, the greater part of which in eastern New York is synchronous with the Chemung and Portage stages.[2] In the early part of 1842, and perhaps as early as the latter part of 1841,[3] Professor James Hall published a paper entitled "Notes upon the geology of the Western States"[4] in which he compared the formations of those states with those of New York. He began with the higher rocks, considered the divisions in descending order and stated that "The great group of fossiliferous shales so well developed along Cayuga and Seneca lakes, and known as Marcellus, Skaneateles, Ludlowville, and Moscow shales, which, for the sake of brevity, I shall speak of under the name of the *Ludlowville group*. This great group, which occupies in New York a thickness not less than 1000 feet, and contains a greater number of individual fossils than nearly all the other groups, thins out in its western prolongation, losing at the same time its distinctive paleontological character."[5] The name, Ludlowville, however, was preoccupied when used by Professor Hall in 1842 for he had already in 1839 applied it to the fissile olive shale on Seneca and Cayuga lakes which he called the Ludlowville shales.[6]

Ludlowville group, as defined by Professor Hall in 1842 has not been retained for this division of the Devonian system. It agrees with the Hamilton period of Dana as restricted in the last edition of the Manual, except that it did not include the Tully limestone[7] and corresponds precisely with the Erian as defined by Clarke and Schuchert.[8]

[1] *Group* was used in the N. Y. reports as equivalent to a formation or lowest stratigraphic division, and not as proposed by the International Congress of Geologists where it is the highest division.

[2] Geology New York, Pt. III, p. 13. For descriptions of the various stages see pp. 146-195.

[3] The signature at the bottom of the page is "Vol. XLII, No. 1, Oct.-Dec., 1841."

[4] Am. Jour. Sci. & Arts, Vol. xlii, 1842, p. 51.

[5] *Ibid.*, p. 57.

[6] 3d An. Rep., Fourth Geol. Dist. [New York], (Assembly Doc. No. 275, 1839), p. 298.

[7] Man. of Geology, 4th ed., 1895, pp. 592, 593.

[8] Science, N. S., Vol. X, 1899, p. 876.

In 1843, Prof. James Hall's final report on the Fourth District, covering western New York, was published, in which the classification is nearly the same as that used by Vanuxem; the only changes concerning that part of the system now under consideration were the uniting of the Ithaca and Chemung groups and the acceptance of Emmons' classification of the Catskill division as the "Old Red system or Old Red Sandstone"[1] which was a correlation with the Old Red Sandstone of England. The same year Mather's final report on the First District was published in which he agreed with Vanuxem in considering the Catskill as the last division of the New York System.[2] He was also of the opinion that the Erie division extended to the top of the Chemung, for he stated that "The Erie division in the First Geological District, consists of the following groups, viz.:

1. Ithaca and Chemung group.
2. Hamilton group.
3. Marcellus shales.

The Portage group, Genesee shales, and Tully limestone of the Erie division, if they exist in the First District, have not been recognized as distinct strata."[3]

In 1846, Volume I of Emmons' Agriculture of New York was published in which he gave a lengthy account of the New York System.[4] The classification remained about the same as in his former report; but some ambiguity exists in reference to the position of the Catskill division or Old Red system and the number of formations composing the Erie division. It is stated that "The New York system admits of four divisions,"[5] which are then listed in ascending order as 1. Champlain, 2. Ontario, 3. Helderberg, and 4. Erie. These are followed by 5. Catskill.[6] Furthermore, under the description of the members composing these

[1] Geology New York, Pt. IV, pp. 18, 19. For descriptions of the various stages see pp. 177-284.

[2] Geology New York, Pt. I, p. 299.

[3] *Ibid.*, p. 317.

[4] Chapter VI, pp. 113-200.

[5] *Loc. cit.*, p. 114.

[6] *Loc. cit.*, pp. 115, 116.

"grand divisions of the New York system" appears No. "V. Catskill Division" composed of the Portage, Ithaca, Chemung, and Catskill groups.[1] It appears probable, however, that the Catskill division was considered as separate from the New York system for it was stated that "It forms by itself a distinct system, and has been described by Mr. Phillips under the name of *Devonian system*. It is designed to embrace not only the peculiar rocks of Devonshire, but those of Scotland, and of places on the Continent which have hitherto been known and described under the name of *Old Red sandstone*,"[2] while on p. 116 he used the expression "The Silurian or New York system" apparently for the Champlain, Ontario, Helderberg, and Erie divisions. Under the classification of the New York rocks where the formations composing the different divisions are briefly tabulated it is stated that the Erie division embraces the Marcellus shale and the Hamilton, Portage, and Chemung groups.[3] In the detailed account of the Erie division, however, only the Marcellus and Hamilton shales and Tully limestone are described,[4] while the Portage and Chemung groups appear under the Catskill division.

Preceding these reports Conrad, who became Paleontologist of the Survey after the first year of field work, published an article in 1842 in which he stated that "The rocks of the Ithaca group, Chemung group, and the Old Red Sandstone near Blossburg, in Pennsylvania, constitute the equivalents of the Devonian system as developed in Europe, and contain a number of the organic remains which characterize the Devonian strata."[5] While Professor Hall in his final report carried the base of the Devonian somewhat lower concluding that the Devonian system appears "To correspond to the Chemung and Portage groups, and also to include a portion of the Hamilton."[6] After the publication of the final reports of the New York Geological Survey the famous French geologist de

[1] *Loc. cit.*, pp. 187-193.
[2] *Loc. cit.*, p. 188.
[3] *Loc. cit.*, p. 116.
[4] *Ibid.*, pp. 180-187.
[5] Jour. Acad. Nat. Sci., Philadelphia, Vol. VIII, p. 232.
[6] *Loc. cit.*, p. 20.

Verneuil visited this country, studied the Paleozoic formations and published an article correlating the Paleozoic deposits of North America with those of Europe.[1] He included the Old Red Sandstone or Catskill group in the Devonian and after some hesitation drew the lower limit at the base of the Oriskany sandstone,[2] and this was generally accepted and followed by American geologists. In 1889, Dr. J. M. Clarke in his paper on "The Hercynian question," showed that the Lower Helderberg probably belongs in the Devonian instead of the Upper Silurian,[3] and recently he and Schuchert have clearly drawn the line of division between the Devonian and Silurian systems at the base of the Lower Pentamerus (Coeymans limestone) and transferred the Lower Helderberg to the Paleodevonian.[4] This correlation is opposed by Prof. H. S. Williams who claims that the Chapman sandstone fauna of Aroostook County in northern Maine is the representative of the Tilestone fauna at the top of the Silurian system in Wales, while below the Chapman sandstone is the Lower Helderberg fauna.[5] This argument has been answered by Dr. J. M. Clarke who states that these arenaceous deposits of Aroostook County, Maine, contain New York Oriskany species together with "A number of species identical with those of Lower Devonian faunas of western Europe."[6]

[1] Bull. Soc. Géol. France, 2d Ser., t. IV, 1847, pp. 646-710, which was translated and condensed by Prof. James Hall and published in four installments in the Amer. Jour. Sci. & Arts, 2d Ser., Vols. 5 and 7. For the first part see Vol. 5, 1848, p. 176.

[2] *Loc. cit.*, p. 677. Am. Jour. Sci., 2d Ser., Vol. 5, p. 367.

[3] 42d An. Rep. State Mus. [N. Y.] Nat. Hist. for 1888, p. 408, and see especially pp. 422-424, 437.

[4] Clarke and Schuchert, Science, N. S., Vol. X, Dec. 15, 1899, p. 876; Schuchert's paper entitled "Lower Devonic aspect of the Lower Helderberg and Oriskany formations," Bull. Geol. Soc. Am., Vol. 11, May, 1900, p. 241; Clarke: Mem. N. Y. State Mus., No. 3, 1900 (N. Y. State Mus., 53d An. Rep. Regents 1899, Vol. 2, 1901), pp. 82-101 and Handbook 19, N. Y. State Museum, 1903, pp. 8, 14; N. Y. State Mus. Mem. 9, 1908, p. 7; Kayser, Lehrbuch, Formationskunde, 3d ed., 1908, p. 172.

[5] Am. Jour. Sci., IV Ser., Vol. IV, March, 1900, p. 213; Bull. Geol. Soc. Amer., Vol. 11, May, 1900, p. 346; Bull. U. S. G. S., No. 165, p. 87.

[6] Science, N. S., Vol. XII, Dec. 28, 1900, p. 992; Proc. Am. Assoc. Adv. Science, Vol. 49, 1900, p. 188; N. Y. State Mus., Mem. 9, Pt. 2.

There is also structural evidence in New York, as reported by Dr. J. M. Clarke, favoring the reference of the Helderbergian series to the Devonian. Dr. Clarke says: "The fauna of the Tentaculite limestone [Manlius] makes its first appearance not far above the gypsum beds, and in its most perfect development it is clearly an uppermost Siluric fauna, having only very remote relations with the fauna of the remaining divisions of the Helderbergian group in eastern New York. The inference that the upper limit of the Siluric system is properly to be placed at the top of the Tentaculite limestone is corroborated by stratigraphic structure which shows in places distinct unconformity between the Tentaculite limestone and the overlying strata."[1]

In 1855, Professor Dana in his address as President of the American Association for the Advancement of Science proposed divisions of geologic time subordinate to the great ages which were Silurian, Devonian, Carboniferous, et cetera; stating that these subordinate divisions would depend "On revolutions in the earth's surface, marked by abrupt transitions either in the organic remains of the region, or in the succession of rocks. Such divisions are not universal. Each continent has its own periods and epochs."[2] Dana called the first subdivision of the ages, periods and these were again divided into epochs, an epoch corresponding in general to that division of the rocks which had been called a group by the New York geologists in their final reports. So the Devonian or Age of Fishes was divided by Dana into the Upper Helderberg, Hamilton, Chemung, and Catskill periods.[3] This classification appearing in greater detail in the first edition of his Manual of Geology published in 1863, has been amplified in the three succeeding editions but its essential characters have not been changed. In the last edition the Devonian was divided into the Oriskany, Corniferous, Hamilton, and Chemung[4] periods. This was, however, only a minor change due to a better knowledge of the formations, the Upper Helderberg period being

[1] N. Y. State Museum. 53d An. Rep. of the Regents 1899, Vol. 1, 1901, p. 671.
[2] Proc. Am. Assoc. Adv. Science, Vol. 9, 1856, p. 5.
[3] *Ibid.*, p. 14.
[4] Man. Geol., 4th ed., 1895, p. 576.

divided into the Oriskany and Corniferous periods, and the Catskill period having disappeared because it is not regarded as a distinct time division but as synchronous with a varying portion of the Chemung period and its later deposits perhaps formed in Carboniferous time. In Dana's last summary of the Devonian, the *Oriskany* period was composed of the Oriskany sandstone; the *Corniferous* of the Schoharie and Corniferous epochs; the *Hamilton* of the Marcellus and Hamilton epochs and the *Chemung* period of the Portage and Chemung epochs, thus in general the name of the epoch corresponding to the best characterized or most widely distributed formation was selected as the name of the period. The deservedly commanding position in American geology held by Dana's Manual for more than the last quarter of a century has made this classification familiar to all students of our geology. It will be remembered, however, that the names used by the New York geologists were for "groups" which usually had the rank of what are now called stages or formations and that they were not applied to divisions of higher order. The use by Dana of the same names for chronologic divisions of higher rank introduced an element of confusion into the classification so that, for example, when the term Hamilton is used it is necessary to state whether it is an epoch or period in the chronologic sense, or a stage or group in the stratigraphic sense. This double use of the same term led to embarrassment in the correlation of the formations of other states with those of New York and in recent years there has been a tendency among some geologists to ignore to an unwarranted extent the New York names and in their work in neighboring states to propose new names for formations which agreed essentially with those of New York.

Dr. Wm. B. Clark, Mr. Bailey Willis, and a few other geologists, however, had insisted that the formation or stage name ought not to be used as the name of the division of next higher rank. This criticism has been recognized as just by Dr. John M. Clarke, the New York State Geologist and Paleontologist. After discussing this question in their joint paper Clarke and Schuchert have said, "The point has doubtless been reached when these terms [Hamilton, etc. in the larger sense] representing though they do important divisions of time and sedimentation, must give way to

others of equivalent value which shall obviate the duplication and confusion with which we are now embarrassed."[1] In accordance with this statement the paper contained a series of names for the periods or groups of the New York series which were derived mostly from characteristic localities in New York state, and the hope was expressed that thus would be preserved "under the necessity of change, the eminent title of New York state to its full and ancient representation in the classification of the Paleozoic deposits and time." In place of the Hamilton period of Dana composed of the Marcellus shale and Hamilton stage, Erian was proposed with the intention of saving the term "Erie division" of the New York geologists, which included all the formations from the base of the Marcellus shales to the top of the Chemung, "to the New York nomenclature by reviving it with a restricted meaning."[2]

ADOPTION OF ROMNEY FORMATION

In connection with the preparation of the maps and text for the folios of the Geologic Atlas of the United States, the United States Geological Survey carefully considered the subjects of geological cartography and nomenclature. In the Tenth Annual Report the Director gave a lengthy account of a conference of a number of geologists connected with the United States Geological Survey held in 1889 at which it was decided that there should be recognized for the clastic rocks both structural and time divisions, and that the structural divisions should be considered the units of cartography and called formations. In the definition of a formation it was stated that "As each lithologic unit is the result of conditions of deposition that were local as well as temporary, it is to be assumed that each formation is limited in horizontal extent; the formation should be recognized and should be called by the same name as far as it can be traced and identified by means of its lithologic characters, aided by its stratigraphic association and its contained fossils."[3]

In 1903, these rules were revised by the United States Geological Survey and the revision published the following year in the Twenty-fourth An-

[1] Science, N. S., Vol. X, p. 875.
[2] *Ibid.*, p. 877.
[3] 10th An. Rept. U. S. Geol. Surv., 1890, p. 64.

nual Report. In the revised rules the stratigraphy and fossils are assigned equal importance with the lithology in the identification of a formation, as may be seen from the last sentence of Rule No. 4, which is as follows: "The formation should be recognized and should be called by the same name as far as it can be traced and identified by means of its lithologic character, its stratigraphic association, and its contained fossils."[1]

The method of naming the sedimentary formations and the names for their subdivisions are given and clearly defined as follows in Rules 5 and 6:

"5. When, for scientific or economic reasons, it is desirable to recognize and map one or more specially developed parts of a varied formation, such parts shall be called *members,* if they have considerable geographic extent; or if their distribution is more limited they shall be described in some appropriate term, such as *lentil.*

"6. All sedimentary formations shall receive distinctive designations. The most desirable names are binomial, the first part being geographic and the other lithologic (*e. g.,* Dakota sandstone, Trenton limestone, etc.). The geographic term should be the name of a river, town, or other natural or artificial feature at or near which the formation is typically developed. Names consisting of two words should be avoided. Names taken from natural features are generally preferable, because less changeable than those of towns or political divisions. When the formation consists of beds differing in character, so that no single lithologic term is applicable, the word 'formation' should be substituted for the lithologic term (*e. g.,* Rockwood formation). Members and other subdivisions shall be named in the same manner, but in the legend of the map the term 'member,' etc., shall always be added to the geographic and lithologic designation (*e. g.,* in the Pottsville formation, the Homewood sandstone member)."[2]

The mapping of the areal geology in the Appalachian part of the Virginias began in 1888 and the first folio, that of Staunton, Virginia,

[1] *Loc. cit.*, p. 23.
[2] *Ibid.*, p. 24.

by N. H. Darton, was published in 1894. A preliminary account of the stratigraphy of this region was published in 1892 in which is a list of the formation names, with one exception, together with descriptions of the formations which appeared in the Staunton folio. In discussing the correlation of these formations with those of New York, Darton said, "Although the greater number of groups of the Lower Paleozoic of New York extend through Pennsylvania, and are more or less distinctly represented in Virginia, many of their component formations lose their distinctive characters, and their stratigraphic range is not apparent in the Virginia sections. Owing to this lack of evidence as to the precise stratigraphic equivalency and range of the Virginia formations in terms of the New York series, the use of New York terms is misleading."[1] In some of the formations at least there does not appear to be as great a difference between the exposures in New York and Virginia as one might expect from the foregoing statement and it appears that the United States Geological Survey in its earlier areal work was inclined to overestimate the differences existing between the Paleozoic formations of the Virginias and Maryland and the standard ones of New York and Pennsylvania. In the two folios of southwestern Pennsylvania by Campbell the standard names of the Pennsylvania and New York classifications are used for the formations.[2] Darton stated that "The Devonian formations in Central Appalachian Virginia comprise from 5000 to 6000 feet of arenaceous and argillaceous deposits, separable into three series. The basal members are fissile shales, in greater part black or dark brown in color, containing occasional thin beds of sandstone and limestone. Their average thickness is about 600 feet." To this formation was given the name Romney shales, from the exposures in the vicinity of Romney, Hampshire County, in northeastern West Virginia. Regarding the fauna and correlation of the formation there is the statement that "In the Romney shales the following species are Corniferous [misprint for conspicuous]: *Discina lodensis, D. minuta, Orthis leucosia, Stropheodonta demissa, Cyrtina*

[1] Am. Geol., Vol. X, 1892, p. 11.
[2] Masontown-Uniontown Folio, No. 82, 1902; and Brownsville-Connellsville Folio, No. 94, 1903.

hamiltonensis, Spirifera mucronatus, S. granulifera, and *Leiorhynchus limitaris.* This is a Hamilton group fauna, but the stratigraphic range of Hamilton group equivalents in the Romney shales is not apparent, and Hamilton deposits probably extend some distance above."[1] Later it will be shown that this formation in northeastern West Virginia and western Maryland consists of the Onondaga and Marcellus shales and the Hamilton stage of New York as shown by its stratigraphic and faunal characters. In other words it is equivalent to the Onondaga and Hamilton series of the older New York classification.

Whether all of the Romney formation succeeding the Marcellus shale belongs in the Hamilton stage or not is uncertain owing to the fact that the upper limit of the Romney was not clearly indicated in the original description, the statement being made that "Hamilton deposits probably extend some distance above" shales in which Hamilton species were collected.[1]

The eastern line of the Piedmont folio crosses the Potomac River not far west of Keyser, while the western belt of the Romney formation of Allegany County crosses the river at that locality and extends up the New Creek valley of West Virginia into the area of the Piedmont folio. In the description of the Romney shales in this folio it is stated that "the upper members contain alternations of thin, pale-brown or dark-buff, sandy beds, which constitute beds of passage into the next succeeding formation.

"The vertical range and stratigraphic position of these passage-beds appear to be somewhat variable, so that there is no definite line of demarcation between the two formations [Romney shales and the succeeding Jennings formation]. Owing to this fact no precise thickness can be assigned to the Romney shales, and on the map the Romney and Jennings patterns have been merged to indicate the intergrading of the two formations."[2]

In Allegany County at the top of the Hamilton shales is another black, fissile shale which contains the fauna of the Genesee shale of New York

[1] Am. Geol., Vol. X, pp. 17, 18.
[2] Geol. Atlas U. S. Piedmont Folio (No. 28), 1896, p. 3, col. 2.

and has been correlated with that stage by the writer. The Genesee shale was orignally classed in the Hamilton series but later writers have shown that its fauna is more closely related to that of the Senecan series in which it is now generally placed. It is not clear to the writer from the descriptions of the Romney formation whether this shale occurs in West Virginia or not but if present it is thought to be included in the Romney formation since it is stated that "The lower members [of the Jennings formation] are light-colored shales, in which olive-gray and buff tints predominate, with interbedded light-colored sandstones, some of which are moderately thick bedded."[1] In Allegany County there is quite a rapid change from the coarser bluish, or olive shales when weathered, of the Hamilton into the fissile black shales of the Genesee. This line is fully as distinct and sharp as that separating many formations and it has been selected by the writer as the line of division between the Romney and Jennings formations. This division agrees with the accepted classification of the Hamilton or Erian series of New York and if not strictly in accordance with the former limit of the Romney shale it is believed that since a precise line was not indicated for the top of that formation, the change is not great enough to necessitate a new name for it. This change simply tends to fix the upper limit of the formation more precisely than was done in the former descriptions and it is thought that it will introduce no confusion concerning its limits because the Genesee shale had not been identified or mentioned as a part of the formation.

The evidence given above for correlating the Romney shales overlying the Onondaga member, with the Marcellus and Hamilton stages of New York is considered conclusive, especially when it is taken into consideration that other sections in the Middle Devonian rocks of southern Pennsylvania, Maryland, and northern West Virginia present a similar array of facts in favor of such correlation. This will be shown in the account of other sections in Allegany and Washington counties as well as in the typical area of the Romney formation near Romney, Hampshire County, West Virginia. In Pennsylvania, Professor Stevenson identified these

[1] *Ibid.*

same stages[1] in Fulton and Bedford counties, which adjoin Washington and Allegany counties on the north. Under his account of the Devonian system he states that, "The Hamilton group as a whole shows within this district the threefold division recognized and named in New York as Genesee shale, Hamilton shale, and Marcellus shale; but owing to the varying thickness of these subdivisions and to the fact that the soft shales yield readily to the weather, one finds much difficulty in identifying them. Especial annoyance is caused by the Genesee shales, which are rarely exposed."[2] And in describing the divisions he reported that "The *Hamilton shales* are rather laminated sandstones, which vary much in hardness. The softer argillaceous shales are not persistent and the harder beds ordinarily make a well-defined ridge, which is almost as high as that of the lower Chemung beds. . . . .

"These shales are often exposed in Bedford County, where the group shows comparatively little variation. The argillaceous shales seldom contain fossils, but the sandy shales or laminated sandstones are usually fossiliferous. *Tropidoleptus carinatus, Spirifera mucronata, Leiorhynchus* sp., and *Streptorhynchus chemungensis,* var. prevail throughout while species of *Bellerophon* and *Pleurotomaria* are abundant in the highest beds. A fine *Spirophyton* occurs at several horizons. The presence of the *Marcellus* is shown at all localities where the sub-group is present, but an exposure affording details for measurement is rare."[3] Two exposures of the Genesee shale were described in both Fulton and Bedford counties; but elsewhere in those counties the exposures were stated to be very indefinite and the rock was described as consisting for the most part of "dark shale, but it contains not a little of brown shale with olive-colored flags."[4] On the Geological Map of Bedford County by Professor Stevenson a band of the Hamilton shale which includes the

[1] Professor Stevenson did not recognize the Onondaga age of the lower shales and included them in his Marcellus. In this respect, therefore, his statements are not in agreement with those of this volume.

[2] 2d Geol. Surv. Penn., T^2, 1882, p. 81.

[3] *Ibid.*, pp. 82, 83.

[4] *Ibid.*, p. 82.

Marcellus, Hamilton, and Genesee shales, according to the text, is represented as following down the valley of Wills Creek and entering Maryland about where the western area of Romney is mapped in the vicinity of Ellerslie. Along the state line on the Pennsylvania county map the lower line of the Hamilton group is carried too far east of Wills Creek; but the general agreement is about as good as could be expected from the representation on base maps of such great difference in topography.

This agreement in the correlation of the formations in western Maryland and southern Pennsylvania is important for the Second Survey virtually traced the Devonian and Silurian formations from New York across the state to Maryland. The writer has studied a part of the Pennsylvania region in the field and although in some of the classification in the northeastern part of the state he differed from the Pennsylvania Survey, in general the formations were accurately correlated with the standard ones of New York. Furthermore, in reference to the claim sometimes made that fossils are unreliable, it is to be said that in the Pennsylvania Survey greater dependence was placed upon the lithology, stratigraphy, and actual tracing of the formations in the field than upon fossils.

Since the Romney formation in Maryland is correlated so precisely with the Onondaga, Marcellus, and Hamilton stages of New York, the question naturally arises why the New York names are not fully accepted for Maryland. As already stated there are obstacles in the way in attempting to map these divisions separately, due, largely, to the gradual change from the lithological characters of one member to another so that in a region of infrequent exposures it becomes difficult to represent a line of division between them. It was deemed best to regard the stages as constituting one formation. The name Romney formation was adopted which had been proposed and defined for this division of the Devonian system in the Virginias.

Furthermore, the Maryland Geological Survey has used only those names for its Middle Devonian and Upper Devonian formations which are acceptable to the United States Geological Survey.

STRATIGRAPHIC AND PALEONTOLOGIC CHARACTERISTICS

THE ROMNEY FORMATION[1]

INTRODUCTORY

In sections wherever shown in Allegany and Washington counties, the Romney formation is immediately underlain by the Oriskany sandstone and the transition from sandstone to shale is abrupt. This contact may be studied to advantage at Monster Rock, opposite Keyser; on the Williams Road $3\frac{1}{2}$ miles southeast of Cumberland and at the iron bridge over Licking Creek, 1 mile east of Warren Point, Pennsylvania, just north of Washington County, as well as at many other points. As will be shown in the description of the sections the Romney formation is composed of three parts: the lower shales representing the Onondaga limestone and Marcellus shales of New York and the succeeding shales and sandstone, the Hamilton stage. It will be remembered that in the standard New York section between the Oriskany sandstone and Marcellus shale is the Ulsterian series of Clarke and Schuchert composed of the Esopus grit, the Schoharie grit and Onondaga or Corniferous limestone.[2] It was long believed that there was no representative of these stages in Maryland and that during that time there must have been a land area in western Maryland. The evidence relied upon to support this view was the supposed absence of the Onondaga fauna. The Onondaga fauna has, however, recently been shown to be present in the lower member of the Romney. There is also a basal conglomerate at some localities in the Romney containing pebbles derived from the Oriskany sandstone which, in connection with a conglomerate at the top of the Oriskany, indicates a temporary emergence and later subsidence of the land. This structure is well shown at the locality east of Warren Point where it was first noticed and described by Rowe. Unconformity by erosion was described by Darton between the

[1] The discussion of the Onondaga member is by Edward M. Kindle. The remainder of the chapter is by Charles S. Prosser.

[2] In the last edition of Handbook 19, New York State Museum, by Hartnagel, the Esopus grit is transferred from the Ulsterian to the Oriskanian series (see table I and p. 62).

Monterey and Romney to the west of Staunton, Virginia, where at its extreme the black shales rest on an irregular, probably eroded surface of the Oriskany.[1] This feature was observed at many places in Maryland. The estimates of the thickness of the Romney formation vary from about 600 to 1650 feet.

SUBDIVISIONS

The Romney shale shows everywhere in Maryland three more or less sharply defined lithologic divisions which are characterized by distinctive faunas. Where the lithologic differentiation is least prominent the three types of faunas found in the Romney shale are still limited to the same relative parts of the section as farther north. The lowest of these faunas is confined to a sedimentary type which includes, mainly, alternating drab or olive green and black shales with occasional thin bands of impure limestone. Following these is a series of generally fissile black shales with comparatively few drab or light-colored shales. The uppermost division includes drab or sandy shales and sandstones with the Hamilton fauna. These divisions are named, in ascending order, the Onondaga, Marcellus and Hamilton members respectively.

Onondaga Shale Member

CHARACTER AND THICKNESS.—This member is more persistent in its lithologic characters than the other two divisions of the Romney. After the latter have become nearly indistinguishable on either a lithologic or faunal basis to the south of Maryland, the drab or dark shales with limestone bands, representing the Onondaga shale, and their distinctive faunas are still easily recognized.

The Onondaga shale is prevailingly lighter in color than the overlying Marcellus shale while many of the beds are blocky. Upon weathering it usually becomes buff or greenish brown, and breaks into irregular fragments, resembling in this respect, the upper part of the Hamilton member, and finally disintegrates into clay. Interbedded with the lighter strata, however, are beds of black, or dark brown, fissile shale, which resemble the shale of the overlying Marcellus very closely. Thin beds of dark, argillaceous limestone occur at several horizons and vary much in thickness and

[1] Am. Geol., Vol. X, 1892, p. 16.

FIG. 1.—VIEW FROM SIDELING HILL SHOWING TOWN HILL IN BACKGROUND.

FIG. 2.—VIEW SHOWING THE MARCELLUS AND HAMILTON MEMBERS OF THE ROMNEY FORMATION AT 21ST BRIDGE.

purity. They play a less important role in the Maryland sections than in Pennsylvania, the dark and drab shale almost, if not entirely, supplanting them locally.

The thickness of this member varies from 100 to 150 feet.

FAUNA.—The Onondaga member contains numerous species many of which are found in the Marcellus and Hamilton of New York. Associated with them, however, are some which are restricted to the Onondaga of New York, including *Anoplotheca acutiplicata,* which is probably the most common member of the fauna, and several trilobites.

ROMNEY-ORISKANY BOUNDARY.—Unconformable relations between the shale of the Onondaga member and the Oriskany sandstone are strongly suggested by the extremely abrupt and complete change in the character of the sediments at the top of the Oriskany sandstone. The lithologic change is from a coarse sand to a very fine-textured shale. The faunal change is equally abrupt. The unconformity which appears to exist between the Oriskany and the Onondaga shale member is to be correlated with the well-known one at the base of the limestone of Onondaga age in western New York, Indiana, and Kentucky. Rowe has shown that a conglomerate develops locally at the base of the Romney as in the section at Warren Point, Pennsylvania, affording additional evidence of this unconformity. Again, the thickness of the Oriskany decreases from 417 feet at Tonoloway to 52 feet at Warren Point, but 15 miles northeast of the former place suggesting erosion of the Oriskany.

Marcellus Black Shale Member

CHARACTER AND THICKNESS.—The Marcellus member of the Romney formation in Allegany County is composed principally of fissile black shale some of which weathers to a yellowish or buff color on long exposure. In comparatively fresh exposures, however, as in the railroad cuts at 21st Bridge the shales are either black or rusty brown after some weathering. The black shales are shown to best advantage in these cuts although, on the Williams Road, 3½ miles southeast of Cumberland, is, perhaps, the most nearly complete exposure of this division with an approximate thickness of 500 feet. In the lower part of some exposures are bands or nodules

of very dark colored thin limestone. The lithological characters of these shales agree closely with those of typical exposures of the Marcellus shales in New York state.

FAUNA.—This member contains a meager fauna comprising but few species and individuals. The most abundant forms are *Liorhynchus limitare, L. mysia,* and *Styliolina fissurella,* which are common in the Marcellus formation of New York.

ONONDAGA-MARCELLUS BOUNDARY.—The contrast between the lithology of the Onondaga and Marcellus shale members of the Romney is generally well marked except near the zone of transition between the two. Black bituminous shales are sometimes conspicuous elements of the lower member but almost invariably form a subordinate part of the beds and are less frequently fissile than those of the overlying Marcellus. Carbonaceous shales comprise a large part if not the whole of the Marcellus member in most sections and are highly fissile. The intergrading of the two types of sediment will, however, always make it difficult in many sections to decide upon a precise plane of separation. This intergrading is of much the same character as that between the Marcellus and Hamilton in New York. In some sections, as at 21st Bridge on the Potomac River, a band of argillaceous limestone terminates the Onondaga shale member.

Hamilton Member

CHARACTER AND THICKNESS.—This member of the Romney formation has an approximate thickness of 1000 feet and is composed of shales and sandstones. In recent exposures the shales, generally bluish or bluish-gray in color, vary in composition from rather coarse arenaceous to those that are fine and argillaceous. The sandstones, which on fresh surface are generally blue or gray in color, are not very coarse in texture and the layers are often less than a foot thick. All of these rocks, however, on long exposure usually present along the highway a slightly greenish or yellowish-gray tint. Two or more prominent sandstone zones varying in thickness from about 30 to 75 feet occur in this member of the formation. The lower one is from 850 to 1050 feet above the base of the formation, in the sections east of Wills Mountain, while the upper zone is at or near the

top of the formation. Both of these sandstone zones are clearly shown in the sections on the Williams Road and at Tonoloway Station, opposite Great Cacapon, and the upper one at Gilpin and above Corriganville. A conglomerate is found about 175 feet below the top of the Hamilton in the sections east of Hancock. In the vicinity of Millstone it becomes conspicuous and forms well defined ridges.

FAUNA.—The shales in many localities are very fossiliferous, especially those between the two sandstone zones, and contain numerous specimens of such characteristic species of the New York Hamilton as *Spirifer mucronatus* (Conrad), *S. granulosus* (Conrad), *Athyris spiriferoides* (Eaton), *Tropidoleptus carinatus* (Conrad), *Chonetes coronatus* (Conrad), *Phacops rana* (Green), and other species. On account of the presence of numerous Hamilton species together with a lithologic similarity and approximate stratigraphic position this division of the Romney formation is regarded as equivalent to the Hamilton stage of New York.

ROMNEY-JENNINGS BOUNDARY.—The boundary between the Hamilton member of the Romney and the Jennings formation is discussed on a subsequent page to which the reader is referred.

DISTRIBUTION OF THE ROMNEY FORMATION

The Romney formation in Maryland is confined to Allegany and Washington counties in the Ridge District of the Greater Appalachian Valley, the larger area occurring in Allegany County. The western area enters this county from Pennsylvania at Ellerslie and, skirting the foot hills of the Allegany Front, crosses to the Potomac River and then extends southwest to the bend in the river at Keyser. In the region between Shriver Ridge and Green Ridge are several areas, mostly narrow, their outline due to the repeated folding of that section. The first one is a V-shaped area the western arm of which passes through the eastern part of Cumberland, the point extending into Pennsylvania, and the eastern arm lying mainly to the east of Evitts Creek and west of Nicholas Mountain extends south, crossing the Potomac River at North Branch where it enters West Virginia. In the valley between Nicholas and Collier moun-

tains is a narrow belt which extends two-thirds of the distance across the state and in the smaller valley to the east of Collier Mountain is a narrower area with less than half the length of the one just described. Immediately to the east is a belt of Oriskany sandstone and then the largest continuous area of Romney in the county is reached which extends for 8 miles along the Potomac River and may be called the Oldtown area from the village of that name in the Potomac valley about two-thirds of the distance across the area. In its western part the uplift of Warrior Mountain brings up the Oriskany sandstone and Helderberg limestones while the similar uplift of Stratford Ridge in its eastern part exposes the Oriskany. About half-way across the county the area greatly decreases in breadth and skirting the eastern side of Warrior Mountain and Iron Ore Ridge enters Pennsylvania to the northeast of Flintstone where it is about three-fourths of a mile in breadth.

The most western area in Washington County extends as a narrow belt from the northeast to the southwest just west of Tonoloway Ridge and may be called the Tonoloway area. It crosses the Potomac River into West Virginia a short distance west of Great Cacapon. Further east in the Hancock area, is a belt about one-half mile in width, upon which Hancock is situated, which crosses the county in a direction parallel to the one just described. The largest area in the county enters it to the southwest of Warren Point, Pennsylvania, makes a horseshoe curve about Elbow Ridge, returns into Pennsylvania crossing Licking Creek, and then turns and recrosses Washington County from the northeast to the southwest reaching the Potomac River at the mouth of Licking Creek. Since this area crosses Licking Creek several times it may be termed the Licking Creek area. To the southeast is the Ernstville-McCoys area which begins at Ernstville and extends eastward to the uplift of North Mountain. The lower shales are shown in Ernstville, and at McCoys Ferry are exposures of the Hamilton beds containing an excellent representation of the Hamilton fauna. This area is the farthest east that the Romney formation is known in Maryland.

In Garrett County the Romney formation is not known to reach the surface, although there is a considerable area of the overlying Jennings.

Exposures of Onondaga Member

Exposure at 21st Bridge.—There is probably no locality in Maryland where the relations of the Onondaga, Marcellus, and Hamilton members of the Romney can be seen to better advantage than at 21st Bridge, 1 mile east of Keyser. The three cuts adjacent to the intersection of the Baltimore and Ohio and Western Maryland railroads, together expose nearly all of the two basal members and a portion of the Hamilton. The lower portion of the Onondaga and the basal Oriskany sandstone are well exposed in the west cut where the section shows the following beds:

	Feet
Drab, rather hard, slightly sandy shale with some calcareous concretions and bands	45
Lead-gray, fissile soft shale, *Orbiculoidea* abundant	40
Oriskany sandstone	30

The highest beds of the Onondaga do not appear in the west cut but are exposed in the east cut of the Western Maryland Railroad at 21st Bridge. These highest beds include at the top about 8 feet of dark argillaceous limestone in strata 6 to 20 inches thick, interbedded with dark shale. They were estimated by Prosser to lie about 168 feet above the base of the Romney, giving a total thickness of about 170 feet for the Onondaga. This limestone holds *Agoniatites expansus* suggesting that it may represent a horizon near that of the " Agoniatite limestone " fauna of New York which, according to J. M. Clarke,[1] was introduced into western New York before the cessation of Onondaga limestone deposition. With the exception of *A. expansus,* however, the fauna of this zone bears little resemblance to the assemblage recorded from the " Agoniatite limestone " of New York.

The following species have been recognized in a collection made by Swartz from a bed about 100 feet above the base of the Romney in a section ascending the hill east of the river one-half mile south of 21st Bridge:

Pholidops cf. areolata
Dalmanella lenticularis
Goniophora sp. undet.
Panenka sp. undet.
Agoniatites expansus.
Phacops cristata

[1] Bull. New York State Mus., No. 49, 1901, p. 137.

A portion of the Marcellus shale is exposed above these limestone beds in the eastern part of this cut. In the Baltimore and Ohio Railroad cut at Twenty-first Bridge nearly the whole of the Marcellus is exposed. The lower part of the beds at the south end of the cut contain in certain strata a great profusion of the flattened shells of *Liorhynchus limitare* which seem to occupy the strata in which they occur almost to the exclusion of other fossils. The southern half of the Baltimore and Ohio Railroad cut is nearly all in the highly inclined, soft bluish-black Marcellus shales which appear to be nearly barren except for the *Liorhynchus limitare* beds in the lower part. The development of minor crumpling and folding in these beds makes it difficult to estimate their thickness. There appears to be more than 100 feet of these nearly barren dark shales between the Onondaga shale and the beds holding the Hamilton fauna. In the northern half of the Baltimore and Ohio Railroad cut about 75 feet of gray argillaceous and sandy shales are exposed. These contain a rich Hamilton fauna with such characteristic species as *Tropidoleptus carinatus* and *Spirifer mucronatus.*

The comparatively poor exposure of the Onondaga shale one-third mile west of Twenty-first Bridge, near Rosedale switch, affords a richer fauna in the lower beds than the cut at Twenty-first Bridge. The most abundant species at this point are *Anoplotheca acutiplicata* and *Orbiculoidea media.*

Exposure at Queens Point, opposite Keyser, West Virginia.—The most westerly exposure of the Onondaga shale in the state occurs opposite Keyser, W. Va., at the foot of the Queens Point cliffs. Only a few feet of drab shales can be seen here. The fossils noted here include *Pholidops* sp. undet., *Bollia ungula* and some goniatite and trilobite fragments. West of this point the structure brings to the surface nothing older than the Upper Devonian.

Exposure on the Williams Road 3½ miles east of Cumberland.—This section affords a nearly continuous exposure of the beds from the Oriskany sandstone to the Parkhead member of the Jennings, and affords a clear conception of the essential characteristics of the different divisions of the Romney. The Hamilton beds are described by Prosser in a subse-

quent chapter. Minor folding makes the Onondaga member appear thicker than it is.[1]

The section begins at the Romney-Oriskany contact at the foot of Nicholas Mountain, east of Mt. Hermon Church, and extends westward on the old Williams Road.

ROMNEY FORMATION

	Feet.	Total.
Hamilton Member		
No. 10. Soft drab shale weathering to small many-sided fragments	250+	1097
No. 9. Gray sandstone with Hamilton fossils *Tropidoleptus carinatus*, etc.	35	847
No. 8. Drab shale weathering in lumpy fragments	150	812
Marcellus Member		
No. 7. Black to drab fissile clay shale grading into next division.	360	662
No. 6. Road leading north, drab or buff blocky shale, a concretionary limestone 9 inches thick is found just below top of this unit. The shale contains: *Strophalosia truncata* (c), *Liorhynchus limitare* (c), *Liorhynchus* cf. *mysia* (a), *Buchiola retrostriata* (r)	45	302
No. 5. Fissile black shale. *Styliolina fissurella* abundant	100	257
Thickness, Marcellus member	505	
Onondaga Member		
No. 4. Green and drab shale. Repetition of bed No. 2 in part	102	157
No. 3. Fissile black shale weathering gray. Repetition of bed at base of Onondaga. *Pholidops* cf. *areolata* (r), *Anoplotheca acutiplicata* large individuals (c), *Agoniatites* cf. *expansus* (r)	55	55
No. 2. Green and drab colored clay shale weathering in one band 10 feet thick to reddish. Minor folding. *Chonetes mucronatus* (a), *Chonetes rugosa* n. sp. (c), *Pholidostrophia pennsylvanica* n. sp. (r), *Anoplotheca acutiplicata* (r), *Anoplotheca camilla* (r), *Ambocoelia umbonata* (a), *Nucleospira* cf. *concinna* (r), *Reticularia* cf. *fimbriata* (r), *Nuculites modulatus* n. sp. (r), *Paleoneilo* cf. *constricta* (r), *Liopteria laevis* (r), *Grammysia* sp. (r), *Euthydesma?* sp. (r), *Modiomorpha subalata* (r), *Naticopsis* sp. (c), *Loxonema hamiltonae* (r), *Euomphalus* sp. (r), *Goniatites* sp. (r), *Bactrites aciculus* (c), *Bollia ungula* (c), *Bollia obesa* (r)	160	
No. 1. Lead gray to black clay shale. *Orbiculoidea lodiensis* var. *media* (a), *Anoplotheca acutiplicata* (a), *Bactrites aciculus* (c), *Enchostoma ?* sp	55	
Thickness, Onondaga member	157	
Oriskany-Romney contact	0	

[1] The original measurements of the author did not allow for this feature. He is indebted to Dr. C. K. Swartz who first called his attention to this fact, and who has revised his estimates of the thickness of the lower beds.

ORISKANY FORMATION

Buff or brownish rather coarse sandstone with numerous fossils.

The fossils were collected from the various beds of the above section. The lowest division contains a profusion of individuals but a very limited number of species. The succeeding bed contains a much more varied fauna and contains many species diagnostic of the Onondaga. The highest fauna which shows definite affinities with the Onondaga is in the succeeding bed which, however, is probably a repetition of the lowest unit described. The black fissile shale occurring 157 to 257 feet above the base is probably to be referred to the Marcellus while the overlying bed 45 feet thick contains a well defined Marcellus fauna.[1]

In this as in many other sections no very sharp line can be drawn between the sediments holding the Onondaga and the Marcellus faunas, the one grading into the other. Taken as a whole, however, the upper, or Marcellus, shales are decidedly blacker and comparatively freer from light-colored shales than is the lower series in which green and drab-colored shales predominate.

The Tropidoleptus carinatus fauna characteristic of the Hamilton was found in a bed of gray sandstone which lies not far above the base of that member.

Exposure east of Oldtown.—One mile east of Oldtown, a cut in the Western Maryland Railroad affords an excellent section of the Onondaga and Marcellus shales. The Hamilton member and its fauna is also exposed a short distance east of this cut. The section exposed here follows:

ROMNEY FORMATION

Hamilton Member

	Feet.	Total.
No. 13. Hard drab sandy shale: *Lingula* sp. undet., *Spirifer mucronatus*, *Ambocoelia umbonata*. *Stropheodonta perplana*, *Tropidoleptus carinatus*	400+	1060
No. 12. Gray fine-grained sandstone, weathering to shaly beds..	50	660
No. 11. Drab and dark steel-gray hard shale, and covered, thickness very uncertain, Hamilton ? (Duplication by local folding)....	250±	610
No. 10. Hard sandy drab shale with three or four thin bands holding *Aulopora* sp. at east end of cut	40	360

[1] Prosser has included all the beds above the base of the black shale, which occur 302 to 662 feet above the base of the section, in the Hamilton. The author would place the Marcellus-Hamilton boundary about 350 feet higher than the horizon selected by Prosser (662 feet above the base of the section).

	Feet.	Total.
Marcellus Member		
No. 9. Hard fissile black shale with some thin bands of blue limestone full of *Ambocoelia virginiana*. (Local folding within this terrane makes impossible any close or precise estimate of thickness)..	100±	320
No. 8. Band of black limestone concretions....................	1	220.5
No. 7. Hard fissile black shale *Styliolina fissurella* nearly barren	115	219.5
Onondaga Member		
No. 6. Dark gray impure limestone in ⅛ to 1 inch bands interbedded with black bituminous shale, *Strophalosia truncata* and *Centronella cf. ovata* abundant in some bands of limestone............	15	104.5
No. 5. Dark lead-gray to blackish shale.......................	40	89.5
No. 4. Lead-gray blocky shale slightly calcareous with numerous goniatites and pelecypods in certain bands.......................	6	49.5
No. 3. Dark lead-gray blocky shale with some slightly calcareous bands: *Dalmanella lenticularis, Modiomorpha subalata, Panenka alternata, Panenka* cf. *dichotoma, Panenka obsolescens* n. sp., *Panenka* cf. *multiradiata, Agoniatites expansus, Phacops cristata* var. *pipa*	30	43.5
No. 2. Soft dark gray to black argillaceous shale..............	12	13.5
No. 1. Fissile soft black shale with well rounded sand grains rather common	1.5	1.5
ORISKANY FORMATION		
Drab or brownish soft shaly sandstone........................	1	
Gray very hard coarse sandstone with Oriskany fossils, dipping east	12	

The strata of this section which are assigned to the Onondaga shale include beds 1 to 6, a total thickness of about 105 feet. In the lower part of the shale below division 3 fossils are scarce with the exception of *Anoplotheca acutiplicata* which is a common species at this horizon. The next higher bed, 3 of the section, contains a rich fauna as shown by the foregoing list.

The succeeding division of the section appears to contain few fossils and none were collected from it.

The 15 feet of dark bituminous limestone at the top of the Onondaga contain in some bands great numbers of minute brachiopods. The two species *Centronella* cf. *ovata* and *Strophalosia truncata* comprise a large proportion of the material of some of these bands.

The next 100 feet of these shales represent the Marcellus. The only fossil observed in them is *Styliolina fissurella* which occurs in abundance in certain beds in the upper part.

The next 100 feet of the fissile black shales, 9 of the section, appears to be barren except for some thin bands of blue limestone which are crowded with the minute shells of a variety of *Ambocoelia virginiana*.

The lowest Hamilton fauna observed appears in some hard sandy beds about 250 yards east of the end of the cut.

Exposure at Tonoloway.—At Tonoloway, opposite Great Cacapon, W. Va., nearly the whole of the Devonian below the Parkhead member of the Jennings is exposed with the exception of the Marcellus shale which is almost entirely concealed in the bottom of a small valley which reaches the Potomac along the strike of the beds of this portion of the section. At the base of the Marcellus shale and immediately above the Oriskany sandstone about 60 feet of interbedded greenish-drab and black blocky shale is exposed representing the Onondaga shale. The following fauna was found in these beds:

Strophalosia truncata	r
Rhipidomella vanuxemi	c
Ambocoelia umbonata	c
Nucleospira concinna	c
Dalmanella lenticularis	c
Anoplia cf. *nucleata*	r
Leptaenisca australis	r
Styliolina fissurella	a
Phacops cristata	r
Bollia ungula	c
Bollia obesa	r
Craterillina sp.	
Polygnathus sp. undet.	r

Four hundred feet or more above this fauna the typical Hamilton fauna appears in this section.

Exposure at Hancock.—At Hancock the Onondaga fauna was found on the hill northwest of town, just east of the old sand quarry, in green blocky clay shale. About 60 feet above the Oriskany sandstone at this locality the following fossils were secured:

Ambocoelia umbonata	r
Styliolina fissurella	a
Phacops sp. undet.	

Typical thin, papery black shales of the Marcellus type are exposed in the shale quarry about 50 feet above this fauna. The Marcellus shale here, as in most of the Alleghany sections, is largely concealed in the slopes of a valley which occupies the easily eroded beds of the Marcellus horizon. They appear to have a thickness of 400 feet or more at Hancock.

Exposure at Berkeley Springs, West Virginia.—A good section of the Onondaga member occurs about 1¾ miles south of Berkeley Springs, W. Va., where the wagon road cuttings expose the Oriskany sandstone and the lower portion of the Romney, including most of the shales holding the Onondaga fauna. The following section was noted here:

ROMNEY FORMATION

	Feet.	Total.
Marcellus Member		
No. 5. Fissile black shale, and covered	250	333
Onondaga Member		
No. 4. Covered	35	83
No. 3. Black blocky argillaceous shale, full of fossils: *Chonetes* sp. (r), *Ambocoelia umbonata* (a). *Nucleospira concinna* (c), *Anoplea nucleata* (c), *Dalmanella lenticularis* (a), *Leptaenisca australis* n. sp. (c), *Pholidostrophia pennsylvanica* n. sp. (r), *Nucula* cf. *corbuliformis* (r), *Cypricardinia ?* sp. (r), *Styliolina fissurella* (a), *Phacops cristata* (c), *Cyphaspis* cf. *stephanophora* (r), *Leperditia ?* cf. *subrotunda* (r)	20	48
No. 2. Drab shale, weathering cherry red in places; fossils scarce: *Craniella hamiltoniae*, *Leptostrophia perplana*, *Ambocoelia umbonata*	18	28
No. 1. Cream or light putty-colored clay shale, with some buffish layers	10	10

ORISKANY FORMATION

Buffish-brown sandstone, crumbling to sand.

The Marcellus in the section is imperfectly exposed and no fossils were observed in it.

Exposures of Marcellus and Hamilton Members

Exposure at 21st Bridge.—The best locality at which to study the Romney formation in its western area in Maryland is near its southern

end in the railway cuts directly north of the 21st Bridge station on the Baltimore and Ohio R. R. This locality is 1¼ miles northeast of Monster Rock and the Oriskany sandstone and Helderberg limestones are well shown in the Baltimore and Ohio R. R. cut on the West Virginia side of the river. On the Maryland side of the river just above the railway bridge is a contact of the Oriskany sandstone and Romney formation. In the ridge to the east of the West Virginia Central R. R. cut the folded Oriskany sandstone is nicely shown. The sections of the Onondaga member in this vicinity are described by Kindle on a preceding page. In the West Virginia Central R. R. cut to the west of the river the black shale and blackish limestones at the top of the Onondaga member are exposed.

The rocks dip steeply down to the cut of the Baltimore and Ohio R. R. which is directly below and only a short distance north of the 21st Bridge. At the southern end of the latter cut are thin, argillaceous, black shales, weathering to a rusty brown or iron color, which are somewhat above the limestones in the West Virginia Central R. R. cut. In some of the layers which are a little more arenaceous and tougher than most of the shales *Liorhynchus limitare* (Vanuxem) occurs abundantly, associated with an occasional other fossil. Some of the specimens of Liorhynchus are very perfect representatives of the species. Many of them, however, in the thin black shales are greatly crushed so that they are as flat as those occurring in the fissile black shales of New York, which they closely resemble, while some of the specimens from the coarser shales are gibbous retaining the normal form of the species. From these shales the following species were obtained: *Camarotoechia prolifica* Hall (?) (poorly preserved specimens), *Liorhynchus limitare* (Vanuxem), *Tropidoleptus carinatus* (Conrad), *Brachiopod* sp. (specimens that seem to have a pustulose or punctate structure, something like *Spirifer fimbriatus* but there is no fold or sinus and rather coarse plications cover the entire surface), *Nuculites triqueter* Conrad (?) (very imperfectly preserved).

The shales here and there contain small somewhat calcareous concretions in which are numerous specimens of *Liorhynchus limitare* (Vanuxem) while some of the concretions are larger and more calcareous.

From the range of the species it will be seen that the fauna is similar

to that of the Marcellus shales in New York. The lithologic character of the shale both before and after weathering agrees perfectly with much of the New York Marcellus. The correlation of these black fissile shales with the Marcellus shale of New York appears to the writer very probable; a conclusion which is supported by various other sections in the lower part of the Romney formation in Allegany and Washington counties as well as in the typical region of the formation near Romney, West Virginia, which was carefully examined in connection with this work.

Succeeding the fine black shales are rather coarser ones changing to thin sandstones or very arenaceous shales. Some of the shales in this zone are very thin and argillaceous and weather to a rusty color like the Marcellus. Other layers are more arenaceous, and vary to thin yellowish-green sandstones in which scarcely any fossils were found. At one place they form a sandstone stratum several feet in thickness composed of fairly thick layers. Fossils occur but infrequently in the lower part of this zone; but increase in abundance in the higher rocks. The following species were collected in this part of the cut: *Lingula clarki* Prosser, *Stropheodonta* sp., *Chonetes mucronatus* Hall, *Chonetes scitulus* Hall, *Chonetes setiger* (Hall), *Chonetes lepidus* Hall, *Camarotoechia prolifica* Hall (imperfect specimen), *Liorhynchus* sp., *Tropidoleptus carinatus* (Conrad) (very abundant in thin layers of these shales), *Spirifer mucronatus* (Conrad), *Nucula bellistriata* (Conrad), *Nuculites triqueter* Conrad, *Leda rostellata* (Conrad), *Cimitaria* (?) sp., *Pleurotomaria* sp. (apex of a specimen, internal impression), *Bellerophon* sp.

This zone shows the transition from the Marcellus to the Hamilton shales and it will be seen that there is not a sharp line of division between them but a gradual change from the fissile black shales of the Marcellus containing *Liorhynchus limitare* (Vanuxem) to the bluish, coarser and fairly arenaceous shales which contain abundant specimens of some of the characteristic Hamilton species. This fauna is especially well preserved in the next higher zone near the northern end of the cut where the fine shales are so badly crumpled that no attempt was made to estimate their thickness although it would be interesting if this could be accurately determined. At the northern end of the cut are rather thin bluish shales, weathering to a rusty color, which contain numerous fossils. In thicker,

bluish, slightly arenaceous and coarser shales, very near the northern end of the cut, fossils are abundant, especially *Tropidoleptus carinatus* (Conrad) numerous large and beautifully preserved specimens of which were collected. Some of the other most abundant species are *Spirifer mucronatus* (Conrad), *Chonetes coronatus* (Conrad), *Chonetes setiger* (Hall), *Chonetes mucronatus* Hall, and *Palaeoneilo constricta* (Conrad). The complete fauna of this zone is as follows: *Spirophyton* sp., *Lingula ligea* (?) Hall, *Stropheodonta (Leptostrophia) perplana* (Conrad), *Stropheodonta (Douvillina) inaequistriata* (?) (Conrad), *Orthothetes variabilis* Prosser, *Chonetes mucronatus* Hall, *Chonetes coronatus* (Conrad), *Chonetes scitulus* Hall, *Chonetes setiger* (Hall), *Chonetes lepidus* Hall, *Chonetes marylandicus* Prosser, *Camarotoechia prolifica* (?) Hall, *Tropidoleptus carinatus* (Conrad) (numerous large and beautifully preserved specimens), *Spirifer mucronatus* (Conrad), *Spirifer granulosus* (Conrad) (pustules nicely preserved), *Spirifer angustus* Hall, *Athyris spiriferoides* (Eaton), *Grammysia circularis* (?) Hall (imperfectly preserved specimen), *Nucula bellistriata* (Conrad), *Nuculites triqueter* Conrad, *Palaeoneilo constricta* (Conrad), *Palaeoneilo emarginata* (Conrad), *Palaeoneilo tenuistriata* (?) Hall, *Mytilarca (Plethomytilus) oviformis* (Conrad), *Actinopteria decussata* (?) Hall (the concentric lines are not as strong as in most of the specimens of this species), *Aviculopecten* (?) sp., *Aviculopecten princeps* (?) (Conrad), *Cypricardella bellistriata* (Conrad), *Cypricardinia indenta* (Conrad), *Bellerophon* sp., *Cyrtolites (Cyrtonella) mitella* (?) Hall, *Phacops rana* (Green), Crinoid stems.

It will be seen from the above list that this fauna is characteristic of the Hamilton stage in New York, while the shales themselves, in lithological characters are not different from many of the fossiliferous Hamilton shales of that state. The exposures in this cut furnish an excellent illustration of the upper Marcellus shales, and the lower part of the fossiliferous Hamilton shales. The black, fissile shales at the southern end containing specimens of *Liorhynchus limitare* (Vanuxem) are very similar to typical outcrops of the Marcellus shale in New York, even to the rusty color when weathered and the calcareous concretions. Again, the succeeding zone of more arenaceous shales with some thin sandstones in which fossils occur rather infrequently is similar to the lower part of the Hamilton

stage, especially as it occurs in eastern New York. Then the northern part of the cut in which both the thin and coarser shales contain abundant specimens of characteristic Hamilton fossils is very similar to typical fossiliferous Hamilton shales of New York. This is an excellent locality for collecting fossils and is one of the best, in the lower Romney shales, to be found in the county.

Exposures in Braddock and Jennings Runs.—As already stated, the best outcrops of the Romney shales in the western belt are in the railroad cuts at 21st Bridge; but in the northern part of the county Braddock and Jennings runs have cut gorges through the Alleghany Front in which the Devonian and Carboniferous formations are, generally, fairly well shown. To the south of Braddock Run is the line of the Georges Creek and Cumberland Railroad along which are frequent cuts affording exposures of the rocks. The greater part of the cut directly east of the Winchester Pike crossing is through the Oriskany sandstone; but at its western end are black, fissile, argillaceous shales which belong in the Onondaga or Marcellus member. These shales are very fissile at the top and black on fresh exposure but weather to a drab color and turn readily into soil. The remainder of the Romney is covered but in the first cut west of Winchester Pike station the rocks are in the Jennings formation with an average dip of 80°. The contact of the Romney and Jennings is concealed. It cannot be far from the Winchester Road. The Romney would appear to have a thickness of about 600 feet in this section. In the Jennings Run section nearly all the Romney is covered; but by the side of the highway a short distance west of Corriganville the upper part of the formation is shown.

Although there are no outcrops of the lower shale at this locality, about 9 miles farther northeast in the continuation of this belt Professor Stevenson reported it as "well exposed in a bluff" perhaps a mile south of Hyndman, Bedford County, Pa.,[1] and also on the County Road north of this town where he stated that "Both the black and the yellow shales of the Marcellus are shown."[2] As already stated the upper part of the formation is clearly shown in the ledges by the side of the highway one-half mile west

[1] T[2], p. 99.
[2] *Ibid.*, p. 105.

of Corriganville where 147 feet of the Romney is exposed above which about 30 feet is covered when the black, fissile shales of the Genesee appear conspicuously and these in turn are succeeded by the shales and sandstones of the Woodmont. This is, probably, one of the best localities in western Maryland for studying the change from the Romney to the Jennings and then the transition from the Genesee shale to the Woodmont member of the Jennings formation. The actual contact of the Romney and Jennings formations occurs in the covered zone of 30 feet though the greater part of it belongs in the Genesee shale as indicated by its thickness in other exposures in Allegany County. The section at this locality is about as follows:[1]

	Thickness.	Total thickness.
Beginning at the eastern end of the road cut there are bluish, arenaceous shales with some layers of thin sandstone, the latter more conspicuous in the lower part of the exposure. The rocks weather to a yellowish-green and are much iron-stained. The upper part of this zone is more argillaceous, composed mostly of thin shales and this portion is near the middle of the Hamilton cut. Certain layers are fossiliferous, *Spirifer mucronatus* (Conrad) and other Hamilton species occurring. The strike is about N. 35° E. and the dip 78° westward	80	80
The succeeding zone consists of shales alternating with sandstones; one stratum of which reaches a thickness of 11 inches; but in this locality the individual sandstone strata do not reach so great a thickness as in some other exposures in western Maryland. Still the zone of sandstones which is generally found near the top of the Romney formation is clearly represented	38	118
The upper 29 feet of the Romney formation, so far as shown in this cut, consists of thin, argillaceous shales in which *Spirifer mucronatus* (Conrad) and *Tropidoleptus carinatus* (Conrad) occur at the very top of the exposure	29	147
Covered zone	30	177
Black fissile shale of the Genesee in the base of the Jennings formation	73	250
Bluish thin shales alternating with sandstones of similar color. One massive stratum with a thickness of 2 feet, 8 inches, is succeeded by greenish shales alternating with thin sandstones. These rocks which form the western part of the cut, the upper portion of which is in the field at a distance of several feet from the highway, are in the Woodmont member of the Jennings formation	230	480

[1] All the sections in this chapter are described in reverse order, *i. e.*, from the bottom upward.

FIG. 1.—VIEW SHOWING BENDING OF ROMNEY SHALE DUE TO CREEP IN CUT OF WESTERN MARYLAND RAILROAD WEST OF TONOLOWAY.

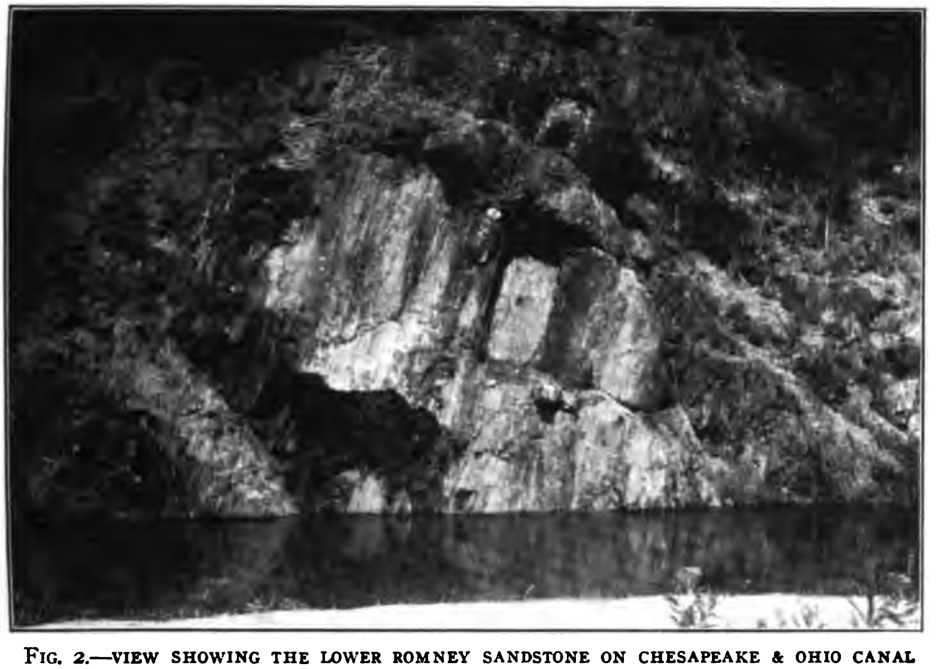

FIG. 2.—VIEW SHOWING THE LOWER ROMNEY SANDSTONE ON CHESAPEAKE & OHIO CANAL NEAR TONOLOWAY.

From the upper part of the Romney formation at this locality the following fossils were collected: *Stropheodonta (Leptostrophia) perplana* (Conrad), *Stropheodonta demissa* (Conrad), *Chonetes mucronatus* Hall, *Chonetes coronatus* (Conrad), *Chonetes setiger* (Hall), *Spirifer mucronatus* (Conrad), *Spirifer granulosus* (Conrad), *Ambocoelia umbonata* (Conrad), *Nucula corbuliformis* Hall, *Leda rostellata* (?) (Conrad), *Pleurotomaria (Trepospira) rotalia* Hall (?), Crinoid stems and segments.

For the remainder of the distance to the Pennsylvania line the Romney shales are mostly concealed.

Exposures near Cumberland.—On the western arm of the V-shaped area of this formation in the vicinity of Cumberland are various exposures, although none of them can be said to afford an opportunity for advantageous study of the fauna or other characters. There are exposures to the north of the city along the National Road, beginning opposite Bellvue Street where the shales are fairly fossiliferous. To the east is McKaig's Hill, composed of the higher and harder Romney shales both of which localities were briefly described by Dr. George H. Williams,[1] who also mentioned a slight depression, in going west from this locality toward the Bedford Road, occupied by the Marcellus shales.[2]

On the Williams Road to the southeast of Cumberland, just beyond the edge of the city, are outcrops of shales by the roadside which on the weathered surfaces have a somewhat olive tint and in this particular they differ from those of the Hamilton in northeastern Pennsylvania and New York, where they may change on weathering from a blackish or bluish color to a brownish tint. These shales are fossiliferous and specimens of *Tropidoleptus carinatus* (Conrad), *Spirifer mucronatus* (Conrad), *Palaeoneilo emarginata* (Conrad), *Rhipidomella vanuxemi* Hall, and other species were seen. The following list was obtained from outcrops on Williams Road about one-fourth mile east of Queen City hotel: *Lingula nuda* Hall (?), *Stropheodonta (Leptostrophia) perplana* (Conrad), *Schuchertella variabilis* Prosser, *Chonetes mucronatus* Hall,

[1] Johns Hopkins Univ. Cir., Vol. XI, No. 94, 1891, p. 26.
[2] *Ibid.*, p. 27.

Chonetes coronatus (Conrad), *Productella* cf. *spinulicosta* Hall, *Rhipidomella vanuxemi* Hall, *Camarotoechia* sp., *Tropidoleptus carinatus* (Conrad), *Spirifer mucronatus* (Conrad), *Spirifer audaculus* (Conrad), *Ambocoelia umbonata* (Conrad), *Nucula bellistriata* (Conrad), *Nuculites oblongatus* Conrad, *Palaeoneilo constricta* (Conrad), *Palaeoneilo fecunda* Hall, *Palaeoneilo emarginata* (Conrad), *Liopteria* cf. *conradi* Hall, *Modiella pygmaea* (Conrad), *Aviculopecten princeps* (Conrad), *Cypricardella bellistriata* (Conrad), *Palaeosolen minutus* Prosser, *Pleurotomaria itys* Hall (?), *Bellerophon* sp., *Homalonotus dekayi* (Green).

About three-fourths of a mile east of the Queen City hotel the following species were collected: *Stropheodonta* (*Leptostrophia*) *perplana* (Conrad), *Rhipidomella vanuxemi* Hall, *Rhipidomella leucosia* Hall, *Tropidoleptus carinatus* (Conrad), *Sprifer mucronatus* (Conrad), *Palaeoneilo emarginata* (Conrad), *Cypricardella tenuistriata* (Hall), Crinoid segments.

Farther up the road are exposures of the Genesee and Woodmont shales of the Jennings formation. The stratigraphic order of this section is complicated by faulting and folding as determined by Dr. R. B. Rowe.

A layer of slightly arenaceous shale on the National Road half way up the hill northeast of Cumberland furnished the following species: *Chonetes mucronatus* (Conrad), *Chonetes scitulus* Hall, *Chonetes setiger* (Hall), *Camarotoechia prolifica* Hall, *Spirifer mucronatus* (Conrad), *Vitulina pustulosa* Hall, *Nuculites oblongatus* Conrad, *Palaeoneilo constricta* (Conrad), *Pleurotomaria itys* (?) Hall (broken specimens).

Rather heavy arenaceous shales on the National Road near the top of the hill and opposite Cemetery northeast of Cumberland gave the following list: *Schuchertella* sp., *Chonetes scitulus* Hall, *Chonetes setiger* (Hall), *Chonetes lepidus* Hall, *Atrypa reticularis* (Linné), *Cyrtina hamiltonensis* Hall, *Spirifer granulosus* (Conrad), *Grammysia bisulcata* (Conrad), *Pterinea flabellum* (Conrad), *Modiomorpha concentrica* (Conrad).

The shales and sandstones on the Oldtown Road, east of Maryland Avenue, Cumberland, have furnished the following list: *Lingula nuda* Hall (?), *Schuchertella* sp., *Chonctes mucronatus* Hall, *Chonetes scitulus*

Hall, *Chonetes setiger* (Hall), *Tropidoleptus carinatus* (Conrad), *Cyrtina hamiltonensis* Hall, *Spirifer mucronatus* (Conrad), *Spirifer granulosus* (Conrad), *Ambocoelia umbonata* (Conrad), *Vitulina pustulosa* Hall, *Tellinopsis subemarginata* (Conrad), *Nucula corbuliformis* Hall, *Nucula bellistriata* (Conrad), *Nuculites oblongatus* Conrad, *Pterinea flabellum* (Conrad), *Paracyclas lirata* Conrad, *Pleurotomaria* (*Bembexia*) *sulcomarginata* Conrad, *Orthoceras bebryx* Hall (?), *Orthoceras constrictum* Vanuxem.

On the south side of the Potomac River, about 3 miles south of Cumberland and on the east side of Knobly Mountain, the following species were collected: *Chonetes* cf. *scitulus* Hall (these specimens are larger than those figured but they have the outline and the large number of striæ), *Chonetes setiger* (?) Hall, *Chonetes lepidus* Hall, *Spirifer mucronatus* (Conrad), *Prothyris lanceolata* Hall, *Tellinopsis subemarginata* (Conrad), *Nucula corbuliformis* Hall. *Nuculites triqueter* Conrad, *Palaeoneilo* cf. *plana* Hall, *Palaeoneilo clarkei* Prosser, *Modiella pygmaea* (Conrad), *Paracyclas lirata* Conrad, *Pleurotomaria* (*Bembexia*) *sulcomarginata* Conrad, *Orthoceras constrictum* Vanuxem, *Orthoceras emaceratum* (?) Hall, *Spyroceras crotalum* (Hall), *Spyroceras nuntium* Hall.

Four miles south of Cumberland on the West Virginia side of the Potomac River opposite Madder's Island, the following species were obtained: *Chonetes* cf. *scitulus* Hall (large specimens similar to those from south bank Potomac River, 3 miles south of Cumberland), *Camarotoechia prolifica* Hall, *Spirifer mucronatus* (Conrad), *Ambocoelia umbonata* (Conrad), *Nucula corbuliformis* Hall, *Nuculites oblongatus* Conrad, *Nuculites triqueter* Conrad, *Modiella pygmaea* (Conrad), *Pleurotomaria* (*Bembexia*) *sulcomarginata* Conrad, *Cyclonema hamiltoniae* Hall, *Loxonema* sp. (fragment of internal impression).

Exposure at Wolfe Mill.—Below Wolfe Mill or Folks Mill along the eastern bank of Evitts Creek are exposures of the rather coarse, bluish, calcareous Hamilton shales. This locality which is on the National Road about 3 miles northeast of Cumberland, is a well-known collecting place of the Cumberland geologists, and the late Robert H. Gordon and others have obtained very good specimens of Hamilton fossils. To

the south of the road on the creek bank the rocks are bluish and in quite firm, coarse layers. There is a steep dip toward the creek between 55° and 57°, N., 40° W. To the north of the pike along the road to the mill the rocks are weathered to a greater extent, having a brownish tint and containing in layers numerous specimens of Hamilton species. The coarse blue shales on the creek bank and the brownish ones along the mill road agree in lithologic characters with the coarser shales of the Hamilton stage in New York. The following list gives a fair idea of the fauna of this locality which would undoubtedly be increased by further search: *Stereolasma rectum* Hall, cf. *Amplexus hamiltoniae* Hall, *Cystiphyllum americanum* (?) Milne-Edwards and Haime, *Rhopalonaria tenuis* Ulrich and Bassler, *Monticulipora* (?) *marylandensis* Ulrich and Bassler, *Lingulella* (?) *paliformis* Hall, *Lingula delia* (?) Hall, *Lingula ligea* (?) Hall, *Lingula* cf. *compta* Hall and Clarke, *Orbiculoidea lodiensis* (Vanuxem), var. *media* Hall, *Craniella hamiltoniae* Hall, *Stropheodonta* (*Leptostrophia*) *perplana* (Conrad), *Stropheodonta demissa* (Conrad), *Stropheodonta* (*Douvillina*) *inaequistriata* (Conrad), *Stropheodonta concava* Hall, *Chonetes mucronatus* Hall, *Chonetes coronatus* (Conrad), *Chonetes setiger* (?) (Hall), *Chonetes lepidus* Hall, *Chonetes vicinus* (Castelnau), *Strophalosia truncata* (Hall), *Rhipidomella vanuxemi* Hall, *Rhipidomella penelope* Hall, *Liorhynchus laura* (Billings), *Tropidoleptus carinatus* (Conrad), *Atrypa reticularis* (Linné), *Cyrtina hamiltonensis* Hall, *Spirifer mucronatus* (Conrad), *Spirifer granulosus* (Conrad), *Spirifer audaculus* (Conrad), *Spirifer angustus* (?) Hall, *Spirifer* (*Reticularia*) *fimbriatus* (Conrad), *Ambocoelia umbonata* (Conrad), *Ambocoelia virginiana* Prosser, *Anoplotheca* (*Coelospira*) *acutiplicata* (Conrad), *Vitulina pustulosa* Hall, *Athyris spiriferoides* (Eaton), *Orthonota* (?) *parvula* Hall, *Tellinopsis subemarginata* (Conrad), *Buchiola halli* Clarke, *Nucula corbuliformis* Hall, *Nucula bellistriata* (Conrad), *Nucula lirata* (Conrad), *Nuculites oblongatus* Conrad, *Nuculites triqueter* Conrad, *Palaeoneilo constricta* (Conrad), *Palaeoneilo plana* Hall, *Palaeoneilo maxima* (?) (Conrad), *Palaeoneilo perplana* var. *grabaui* Prosser, *Palaeoneilo emarginata* (Conrad), *Palaeoneilo tenuistriata* (?) Hall, *Parallelodon hamiltoniae* (Hall), *Pterinea flabellum* (Conrad), *Leptodesma*

rogersi Hall, *Mytilarca* (*Plethomytilus*) *oviformis* (Conrad), *Actinopteria decussata* Hall, *Modiella pygmaea* (Conrad), *Aviculopecten* sp., *Modiomorpha concentrica* (Conrad), *Modiomorpha subalata* (Conrad), *Modiomorpha mytiloides* (?) (Conrad), *Cypricardella bellistriata* (Conrad), *Cypricardinia indenta* (Conrad), *Paracyclas lirata* (?) Conrad (small imperfect specimen), *Paracyclas tenuis* Hall, *Pleurotomaria* sp., *Pleurotomaria capillaria* Conrad, *Bellerophon brevilineatus* (?) Conrad, *Bellerophon* (*Bucanopsis*) *leda* Hall, *Loxonema hamiltoniae* Hall, *Platyceras* sp., *Platyceras* cf. *symmetricum* Hall, *Diaphorostoma lineatum* (?) Conrad, *Styliolina fissurella* (Hall), *Coleolus tenuicinctus* Hall, *Orthoceras subulatum* (?) Hall, *Orthoceras constrictum* (?) Vanuxem, *Orthoceras* cf. *exile* Hall, *Phacops rana* (Green), *Dalmanites* (*Cryphaeus*) *boothi* (Green).

Exposure on Williams Road.—The best continuous exposure of the Romney formation in the vicinity of Cumberland is on the Williams Road about 3½ miles southeast of the central part of the city. The exposures are by the side of the road and are badly weathered, while the road itself winds to a considerable extent making the estimate of thickness somewhat unreliable, still it is probably upon the whole the best section in the vicinity of the city for the purpose of obtaining a general idea of the nature of the formation. Its base is on the western slope of Nicholas Mountain not far east of Mt. Hermon Church and a road which turns to the north. The section was divided into a number of zones which were examined quite diligently for fossils and the lithological characters were also noted with care. The thickness of the zones was estimated but as the road is not at right angles to the strike, frequent determinations of the dip were difficult to make and the estimates are to be regarded as only an approximation.

	Thickness.	Total thickness.
The Oriskany sandstone is fairly well shown on the western side of this mountain, a section of which was given by Dr. O'Harra in his report on Allegany County. The top, consisting of about 16 feet of much decomposed yellowish sandstone containing many fossils is clearly shown and this is capped by 2 inches of coarse, blackish, non-fossiliferous sandstone. By the side of the highway the contact between the Oriskany sandstone and the dark Onondaga shales at the base of the Romney is well shown.		

	Thickness.	Total thickness.
The section of the Onondaga shale member at this place is described by Kindle, to whose account the reader is referred.		
The upper beds of the Onondaga are mainly yellowish to buff very argillaceous shales as shown in the weathered outcrops. This zone contains but few fossils. The overlying beds are of Marcellus age	62	
Fine, argillaceous shales of a blackish to bluish-black color which in the lower part weather to a slightly purplish tint. There are very few fossils in the zone; but near its center a poorly preserved specimen, apparently a *Liorhynchus limitare* (Vanuxem), was found. A dip of 68° W. was measured on some of these shales	98	98
From the top of the bluish-black shales almost to the road turning north. The zone is composed of yellowish to buff very argillaceous shales. There are occasional bands of rather blackish shales which are quite conspicuous in the mass of lighter colored ones...	62	160
Black, fissile, argillaceous shales at the side of the road turning north. The dip changes at this point and, possibly, this zone is not a continuation of the section	23	183
About 60 feet is covered opposite the Mt. Hermon Church	60	243
Fine, argillaceous shales, of bluish-gray color, which split into thin pieces. These shales with a thickness of about 208 feet have the lithologic appearance of the Hamilton but fossils are rare	208	451
Covered	78	529
Fine, yellowish-gray argillaceous shales. No fossils found	164	693
Bluish, arenaceous shales at the base changing into thin bedded to fairly massive, gray sandstones at the top of the zone. Both shales and sandstones are fossiliferous. This is the *lower sandstone zone*	75	768
Yellowish to greenish-gray argillaceous shales which crumble into small pieces and when weathered are greatly iron stained. They contain some fossils, as for example, specimens of *Spirifer*, *Chonetes*, and *Orthoceras*	87	855
Covered	36	891
Principally shales which weather to a yellowish or brownish color; and, apparently, before weathering vary from a light gray to a yellowish-green. There are some fossils but, as in all the Hamilton zones of this section, it is not a favorable locality for collecting	295	1186
Thin bedded greenish to yellowish-gray sandstones. This zone occurs near the top of the first hill southwest of Mt. Hermon Church and it is near the top of the Hamilton stage. This is the *upper sandstone zone*	30	1216
Buff, argillaceous shales on the crest of the hill with a thickness of about 65 feet. This zone forms the top of the Romney formation which then has a thickness of 1438 feet as measured on		

	Thickness.	Total thickness.
the Williams Road.[1] Succeeding the shales is a narrow covered zone on the highway and then an exposure of about 75 feet of argillaceous shale weathered to a brownish tint is reached which is in the Genesee at the base of the Jennings formation. This is followed by the greenish argillaceous shales with thin sandstones of the Woodmont member of the Jennings which continue down the western slope of the hill	65	1281

The following species were collected from the Hamilton beds of the above section: *Lingulella* (?) *paliformis* Hall, *Lingula* cf. *nuda* Hall, *Pholidops hamiltoniae* Hall (?), *Stropheodonta* (*Leptostrophia*) *perplana* (Conrad), *Schuchertella variabilis* Prosser, *Chonetes mucronatus* Hall, *Chonetes coronatus* (Conrad), *Chonetes scitulus* Hall (?), *Chonetes setiger* (Hall), *Chonetes lepidus* Hall, *Rhipidomella cyclas* Hall (?), *Orthis* sp. (small forms), *Camarotoechia congregata* (Conrad), *Camarotoechia prolifica* Hall, *Liorhynchus laura* (Billings), *Tropidoleptus carinatus* (Conrad), *Spirifer mucronatus* (Conrad), *Spirifer audaculus* (?) (Conrad), *Ambocoelia umbonata* (Conrad), *Anoplotheca* (*Coelospira*) *acutiplicata* (Conrad), *Vitulina pustulosa* Hall (?), *Phthonia sectifrons* (Conrad), *Grammysia arcuata* (Conrad), *Tellinopsis subemarginata* (Conrad), *Nuculites triqueter* Conrad, *Palaeoneilo constricta* (Conrad), *Modiella pygmaea* (Conrad), *Modiomorpha concentrica* (Conrad) (?), *Cyclonema liratum* Hall var. *grabaui* Prosser, *Homalonotus dekayi* (Green).

In general, it may be said, on comparing the rocks of the Williams Road section with the one at 21st Bridge that they are weathered to a much greater extent and a considerable part are much more yellowish. The limestones of the Onondaga shales were not found on the Williams Road nor as many specimens of *Liorhynchus limitare* (Vanuxem) as in the Baltimore and Ohio R. R. cut at 21st Bridge. Again, the very fossiliferous zone of the Hamilton as exposed in the cut near the 21st Bridge was not recognized while the sandstones of the upper part of the Williams Road are not shown in the southwestern section which, possibly, does not extend as high in the Romney formation.

[1] Dr. Swartz's estimate of 157 feet for the thickness of the Onondaga member is used in this estimate of the thickness of the Romney formation.

Exposure at Gilpin.—This section is in the northern part of the county on the National Road and Flintstone Creek to the southeast of Flintstone. At the eastern end of the gap cut by Flintstone Creek through the northern end of Warrior Mountain is the top of the Oriskany sandstone. The dip of the Upper Oriskany is 34° E. at this locality. The shales at the contact of the Oriskany and Romney are not shown; but in the field on the northern side of the road is an outcrop of quite black, thin, argillaceous shale with thin bedded sandstones some distance east of the Oriskany sandstone.

There are occasional outcrops along the National Road to the east of the Oriskany sandstone and in the eastern part of Gilpin are outcrops of bluish-green shales which in layers are very fossiliferous. A fairly massive sandstone was also noted in this part of the section.

On the bank of Flintstone Creek just south of and opposite Gilpin is a good exposure of the Hamilton shales in the upper part of the Romney formation. They are bluish and arenaceous with an occasional layer of thin sandstone. The dip is 30° E. Thin layers of these shales contain abundant fossils as *Spirifer mucronatus* (Conrad), *Tropidoleptus carinatus* (Conrad), *Chonetes,* and a few other species among which may be mentioned *Pterinea flabellum* (Conrad). A 3-inch fossil band composed largely of *Spirifer mucronatus* (Conrad) occurs at the lower end of the outcrop. The shales crumble into rather irregular, angular, small blocks in a manner very similar to that of many of the thin bedded, arenaceous Hamilton shales in New York. The fauna of this locality is as follows: *Stropheodonta* (*Leptostrophia*) *perplana* (Conrad), *Chonetes mucronatus* Hall, *Chonetes coronatus* (Conrad), *Chonetes scitulus* Hall, *Chonetes setiger* (Hall), *Chonetes lepidus* Hall, *Chonetes vicinus* (Castelnau) (?), *Camarotoechia congregata* (Conrad) (?), *Tropidoleptus carinatus* (Conrad), *Atrypa reticularis* (Linné), *Spirifer mucronatus* (Conrad), *Spirifer granulosus* (Conrad), *Spirifer tullius* Hall, *Ambocoelia umbonata* (Conrad), *Nucula bellistriata* (Conrad), *Nuculites oblongatus* Conrad, *Nuculites triqueter* Conrad, *Parallelodon hamiltoniae* (Hall), *Pterinea flabellum* (Conrad), *Mytilarca* (*Plethomytilus*) *oviformis* (Conrad), (?) *Modiomorpha* sp., *Modiomorpha concentrica* (Conrad), *Cypri-*

cardella bellistriata (Conrad), *Pleurotomaria* (*Bembexia*) *sulcomarginata* Conrad.

On the National Road in Gilpin, 200 yards west of the bridge over Town Creek, the following species were collected in the arenaceous layers of the upper Romney: *Stropheodonta* (*Leptostrophia*) *perplana* (Conrad), *Schuchertella* sp., *Chonetes mucronatus* Hall, *Chonetes lepidus* Hall, *Tropidoleptus carinatus* (Conrad), *Spirifer mucronatus* (Conrad), *Ambocoelia umbonata* (Conrad), *Paracyclas lirata* Conrad, *Cyrtolites* (*Cyrtonella*) *mitella* Hall.

The lithological appearance and fauna of this zone are those of the typical New York Hamilton in which stage it clearly belongs. It is in the upper part of the Romney formation.

Although the exact contact of the Hamilton and Genesee shales is not shown, still the covered interval is not great and it is thought that the thickness of the Romney formation along the National Road through Gilpin is given quite accurately. The eastern ridge crossing the road in Gilpin was considered the upper sandstone of the Romney which is about on the line of strike with the highest exposure of the formation shown on the bank of the creek. The rocks immediately succeeding this sandstone are covered but allowance was made for the shale at the top of the Romney while the base of the formation is clearly marked at the western end of Gilpin by the Oriskany sandstone. There is, apparently, no folding in this distance and the direction is nearly at right angles to the strike so that the locality is favorable for measuring the thickness of the formation. The average dip of the exposures from the top of the Oriskany sandstone to the top of the Romney formation is about 30°. The paced distance from the top of the Oriskany sandstone to the top of the lower sandstone near the corner of the road leading north in Gilpin is 2080 feet which gives a thickness of 1040 feet. The paced distance from the base to the point at which the top of the Romney was drawn above the second sandstone, is 3180 feet which gives a thickness of 1590 feet for the formation. The same distance measured by the buggy wheel gave a horizontal distance of 3205 feet and a thickness of 1602 feet. An independent measurement at this locality by Rowe gave a thickness of 1605 feet for

the Romney formation. On account of the fairly definite limits of the formation at Gilpin, the absence of folds, and the direction nearly at right angles to the line of strike it is probable that this is as reliable an estimate of the thickness of the Romney formation as has been obtained in Allegany County.

This belt of the Romney formation may be followed northeasterly across the eastern part of Bedford County, and in the northeastern part of it. Professor Stevenson gave two measurements of the thickness of the rocks representing this formation. On Yellow Creek to the northwest of Hopewell he obtained 1756 feet, but the upper limit was uncertain and the lower portion difficult to measure,[1] from which is to be deducted 200 ± feet of Genesee shale,[2] which was included in his Hamilton[3] group, leaving 1556 feet for the thickness of the rocks equivalent to the Romney. Somewhat farther northeast, near Saxton, he obtained 1587 feet for the total thickness of these shales,[4] which agrees very closely with our result in Gilpin.

About 3 miles southwest of the Gilpin section by the side of the road turning northeast and crossing Warrior Mountain from Rush, are exposures of black argillaceous shales in which a few specimens of goniatites were found and there are also quite large concretions of blackish limestone one of which is over 2 feet in diameter. These shales are in the Onondaga member of the Romney formation, but the Hamilton part of the formation to the eastward is mostly covered.

On the east side of the gap in Warrior Mountain, however, to the east of Rush, the following species were obtained: *Chonetes mucronatus* Hall, *Spirifer mucronatus* (Conrad), *Spirifer audaculus* (Conrad), *Spirifer angustus* Hall, *Spirifer sculptilis* var. *marylandensis* Prosser, *Spirifer* sp., *Nucula corbuliformis* Hall, *Pterinea flabellum* (Conrad), *Nyassa arguta* (?) Hall, *Pleurotomaria* (*Bembexia*) *sulcomarginata Conrad,* (?) *Cyclonema hamiltoniae* Hall (poorly preserved specimen), *Homalonotus dekayi* (Green).

[1] T^3, p. 226.
[2] *Ibid.*, p. 82.
[3] *Ibid.*, p. 81.
[4] *Ibid.*, p. 82.

Exposures of Southern Allegany County.—The belt of Romney, just described at Gilpin, when followed more than one-half the distance across the county to the south, becomes broader and because of repetition by folding, the formation extends for 8 miles along its southern border. There are various exposures, still in most of them the rocks are badly weathered and the folding has made it well nigh impossible to form any satisfactory estimate regarding their thickness. Outcrops were studied at a number of localities, the most important of which will be somewhat briefly described.

In the eastern part of the area in Town Creek Valley north of Stratford Ridge are exposures of coarse arenaceous shales by the side of the highway directly north of Mr. George Diefenbaugh's house. The shales are bluish and contain a good many fossils among which are such characteristic Hamilton species as *Spirifer mucronatus* (Conrad), *Tropidoleptus carinatus* (Conrad), *Pterinea flabellum* (Conrad), and other species. The complete list is as follows: *Stropheodonta (Leptostrophia) perplana* (Conrad), *Chonetes mucronatus* Hall, *Chonetes lepidus* (?) Hall, *Tropidoleptus carinatus* (Conrad), *Spirifer mucronatus* (Conrad), *Spirifer granulosus* (Conrad), *Ambocoelia umbonata* (Conrad), *Palaeoneilo* sp., *Pterinea flabellum* (Conrad), *Actinopteria* cf. *boydi* (Conrad),[1] *Pleurotomaria (Bembexia) sulcomarginata* Conrad.

It will be seen that the fauna is a Hamilton one and the lithologic appearance of the shales is like that of numerous outcrops of arenaceous Hamilton shales in New York.

Somewhat farther south by the side of the same road and south of Mr. Rufus Diefenbaugh's house are fine, black, argillaceous shales becoming brownish to chocolate colored on weathering. They contain good specimens of *Styliolina fissurella* (Hall) and *Liorhynchus limitare* (Vanuxem) though most of the latter specimens are very much crushed and the markings are nearly obliterated. These shales are fully as fissile and black as any of the Marcellus shales in New York in which stage they belong.

[1] Although Hall mentions rarely finer intercalated rays for this species and none are shown in the figures, there is in the above specimen a finer ray between the two coarser ones which are cancellated by concentric lines.

Three miles northeast of Oldtown where the road to Green Ridge crosses the iron bridge over Town Creek, is an excellent outcrop of Hamilton shales shown in the highway cut on the western bank of the creek. The shales are rather coarse, somewhat arenaceous, bluish in color, some of them weathering to a buff and very fossiliferous, large numbers of *Spirifer mucronatus* (Conrad) occurring associated with other species. Some of the layers in the upper part of the exposure contain numerous specimens of *Spirophyton*. The other most abundant species are *Tropidoleptus carinatus* (Conrad) and *Chonetes*. The number of species is not large but it is a magnificent locality for specimens of *Spirifer mucronatus* (Conrad). The complete list obtained at this locality is as follows: *Stropheodonta* (*Leptostrophia*) *perplana* (Conrad), *Chonetes mucronatus* Hall, *Chonetes scitulus* Hall (some of the large forms), *Chonetes setiger* (Hall), *Chonetes lepidus* Hall, *Chonetes vicinus* (Castelnau) (some of these specimens have very much the outline of the gibbous specimens figured in the New York report as *Chonetes gibbosus* which is a synonym of *Chonetes deflectus=vicinus*), *Camarotoechia congregata* (Conrad), *Eunella lincklaeni* Hall, *Tropidoleptus carinatus* (Conrad) (medium-sized specimens abundant in some of the blocks), *Cyrtina hamiltonensis* Hall, *Spirifer mucronatus* (Conrad) (abundant and excellent specimens of the mucronate form; some of the layers of rock composed largely of shells of this species), *Spirifer granulosus* (Conrad), *Ambocoelia umbonata* (Conrad), *Athyris spiriferoides* (Eaton), (?) *Meristella* sp., *Nuculites oblongatus* Conrad (internal impression), *Pterinea flabellum* (Conrad), *Actinopteria* sp., *Aviculopecten* cf. *princeps* (small, imperfect specimen), *Pleurotomaria* (*Bembexia*) *sulcomarginata* Conrad, *Bellerophon* sp., *Styliolina fissurella* (Hall), *Tentaculites bellulus* Hall, *Homalonotus dekayi* (Green).

The fauna is that of the Hamilton and the appearance of the rocks is almost identical with that of similar shales in the Hamilton of New York, to which stage these shales belong.

By the highway leading west from Oldtown and opposite the church, are outcrops of olive, argillaceous shales, with an occasional thicker mealy layer, which weather to a buff color and readily disintegrate into soil.

No fossils were found. On the eastern side of Big Spring Run at the highway crossing some 3 miles northwest of Oldtown, are very smooth, black, argillaceous shales, agreeing in lithologic appearance with the Marcellus shales. One layer is thicker and somewhat arenaceous. The dip is between 43° and 45° nearly S. E., and no fossils were found. This locality is near the southern end of Warrior Mountain and not far from the Oriskany sandstone which was brought up by that uplift. Farther up the run on its southern bank are bluish-black shales which, on weathering, break into rectangular pieces and become rusty brown in color. This outcrop occurs after crossing the axis of Warrior Mountain and on its western side with a dip of between 9° and 10° S. The rocks are probably in the lower part of the Hamilton stage.

On the road east of Pine Hill, about 4 miles north of Oldtown, the following species were collected by O'Harra: *Stropheodonta* (*Leptostrophia*) *perplana* (Conrad), *Chonetes mucronatus* Hall, *Camarotoechia prolifica* Hall, *Eunella lincklaeni* Hall, *Tropidoleptus carinatus* (Conrad), *Cyrtina hamiltonensis* Hall, *Spirifer mucronatus* (Conrad), *Spirifer granulosus* (Conrad), *Actinopteria decussata* Hall, *Bellerophon* sp., *Bellerophon brevilineatus* Conrad (?), *Cyrtolites* (*Cyrtonella*) *mitella* Hall (?), *Orthoceras bebryx* Hall (?), *Orthoceras* cf. *aulax* Hall, *Homalonotus dekayi* (Green), *Phacops rana* (Green).

The following specimens are in the Johns Hopkins University collection from the Hamilton of western Maryland but without exact locality labels: *Schuchertella* sp., *Camarotoechia congregata* (Conrad), *Camarotoechia sappho* Hall, *Cyrtina hamiltonensis* Hall, *Spirifer audaculus* (Conrad), *Ambocoelia umbonata* (Conrad), *Nucula* sp., *Tancrediopsis clarkei* Prosser, *Modiomorpha concentrica* (Conrad), *Paracyclas lirata* Conrad, *Pleurotomaria itys* Hall (?), *Bellerophon* (*Patellostium*) *patulus* Hall (?), *Macrochilus hamiltoniae* Hall, *Spyroceras crotalum* (Hall), cf. *Gomphoceras pingue* Hall.

Exposure West of Tonoloway Ridge.—In Washington County are several areas of Romney rocks, mainly narrow belts crossing the county in a direction about northeast to southwest from Pennsylvania to West Virginia. The most western belt in the county is the one to the west of

Tonoloway Ridge which crosses the western part of Hancock township from Pennsylvania to the Potomac River in a direction about parallel with that of the ridge. The belt of lower country between Tonoloway Ridge and Sideling Hill is composed mainly of rocks belonging in the Romney, Jennings, and Catskill formations.

No. 1. The first exposure of Romney shale in following the National Road west from Hancock occurs after crossing Tonoloway Ridge, about 3 miles west of the village. The outcrops of clearly argillaceous, sparingly fossiliferous shales, buff to olive in color especially by the roadside, weather to a decidedly buff color and are often stained with reddish spots or streaks; while at certain places they vary from very light gray to an almost whitish color. This exposure which belongs in the lower, fine, nearly unfossiliferous shales of the Hamilton, occurs by the barn where the road turns south. A little farther west is a second outcrop by the house in which the shales have about the same lithologic appearance. No fossils were found and on weathering these shales are decidedly buff in color and the edges of the breaks are clearly stained red from the iron which they contain.

No. 2. On top of the knoll to the west are olive, very argillaceous shales which when weathered have a decidedly buff to reddish color. Some of them have concentric reddish layers, the tint probably due to weathering and the presence of iron. *Spirifer mucronatus* (Conrad) was found.

No. 3. A little farther west on the road, about one-quarter mile west of Tonoloway Ridge, are somewhat arenaceous, gray to bluish-gray blocky shales which break into more rectangular pieces and contain numerous specimens of *Spirifer mucronatus* (Conrad) though with this exception fossils are not common. The following species were obtained: *Chonetes coronatus* (Conrad), *Tropidoleptus carinatus* (Conrad), *Palaeoneilo muta* Hall (?), *Tentaculites attenuatus* Hall.

On the National Road about one-half mile west of Tonoloway Ridge the following species were found: *Schuchertella* sp., *Chonetes coronatus* (Conrad), *Chonetes scitulus* Hall, *Chonetes setiger* (Hall), *Chonetes lepidus* Hall, *Tropidoleptus carinatus* (Conrad), *Spirifer mucronatus* (Conrad), *Nucula bellistriata* (Conrad), *Nuculites oblongatus* Conrad,

Palaeoneilo sp., *Palaeoneilo rowei* Prosser, *Leda rostellata* (Conrad), *Pterinea flabellum* (Conrad), *Pleurotomaria (Bembexia) sulcomarginata* Conrad (?), *Pleurotomaria (Trepospira) rotalia* Hall (?), *Diaphorostoma lineatum* (Conrad) (?), *Tentaculites attenuatus* Hall, *Phacops rana* (Green).

A little higher more argillaceous and nearly olive shales occur in which there are more species, *Chonetes* being abundant. This zone is but a few feet in thickness when the shales again change to those that are nearly bluish-gray, containing about the same species. On the bank of the creek below the road are bluish-gray to gray shales which are decidedly argillaceous in composition, and when weathered more nearly buff in color though along the stream they are for the most part quite compact and bluish. Some of the layers show large, irregular, concretionary structure. These shales which are quite bluish and contain numerous small concretions, some of which are calcareous, are about in line with the weathered buff and red shales of the middle outcrop on the road above. A few specimens of *Spirifer mucronatus* (Conrad) were found in the shales on the bank of the creek but they are rare.

A ledge of fairly massive, greenish-gray sandstone, as weathered, occurs by the side of the road which is near the top of the Romney formation. It is supposed to be at about the same horizon as the sandstones in Allegany County which occur near the top of the Romney. The sandstone is quite compact, breaks into block-like pieces and has a dip of 60° N., 50° W. The rocks are pretty well covered along this part of the road which is to be regretted because the line of transition from the Romney to the Jennings formation is thereby obscured. No fossils were found but there is very little opportunity to hunt for them as the rocks are so highly inclined and the outcrops are so slight. After crossing a narrow covered area there are fissile, olive shales with an occasional thin sandstone, 2 or 3 inches in thickness. These shales stand at a high angle and only the loose pieces could be examined but in these were found fragments of *Pterochaenia fragilis* (Hall) and *Goniatites*. These rocks do not have the lithologic appearance of the Genesee shales of Allegany County, which appear to be wanting, and they were referred to the

Woodmont member of the Jennings. There is no doubt but that they are above the Romney and in the basal portion of the Jennings formation.

Exposure at Tonoloway.—A much better section of the Romney is shown in the cuts of the Western Maryland Railroad at Tonoloway Station. The lower part of this section is referred to the Onondaga by Kindle who describes it more fully on a preceding page.

	Thickness.	Total thickness.
No. 1. The contact of the Oriskany sandstone and Romney is nearly in the rear of the Lockkeeper's house, but the shales for some little distance above the sandstone are covered. The layers of the lowest shales exposed are fairly thick, some of them varying from 1 to 2½ inches. Some of them are drab in color and they contain the most fossils found in this zone. The number of species and specimens, however, is small. The lower shales are succeeded by those that are thinner, varying from bluish-black to black which in lithologic appearance resemble much more closely the usual Marcellus shale. Fossils are very rare but specimens of *Styliolina fissurella* (Hall) were found and a broken specimen, apparently, of *Liorhynchus limitare* (Vanuxem). The dip varies from 45° to 70° or more, but now and then the thin shales are greatly contorted and crushed so that it is difficult to measure the thickness accurately. In general, the exposure appears to agree better with the Onondaga and Marcellus than the Hamilton and it is thought that they represent those members of the Romney formation	328	328
No. 2. Succeeding these thin shales are bluish, somewhat irregular sandy shales which extend to Possum Hollow Run and are similar to the Hamilton beds containing Hamilton fossils and clearly belonging in that member of the Romney formation. The greater part of this zone is covered	479	807
No. 3. To the west of Possum Hollow Run are bluish Hamilton shales and some thin bedded sandstones. The rocks from the base of this zone to the western end of the section are excellently shown along the bank of the canal where they form a high steeply-dipping cliff. The dip, in general, is about 70° for the remaining part of the section	225	1032
No. 4. *Lower sandstone zone*, composed mainly of bluish, not very thick bedded sandstones, which is conspicuous on the bank of the canal	57	1089
No. 5. Following No. 4 are bluish-gray, arenaceous shales with an occasional thin sandstone stratum. These shales split into rather irregular pieces and in lithologic appearance closely resemble the Hamilton arenaceous shales of New York. They are		

	Thickness.	Total thickness.
very fossiliferous and contain numerous specimens of *Spirifer mucronatus* (Conrad) and *Tropidoleptus carinatus* (Conrad) while other species are common. It is a typical Hamilton fauna as will be seen from the following list: *Chonetes mucronatus* Hall, *Chonetes coronatus* (Conrad), *Chonetes setiger* (Hall), *Spirifer mucronatus* (Conrad), *Prothyris lanceolata* Hall, *Paracyclas lirata* Conrad, *Diaphorostoma lineatum* (?) Conrad, *Coleolus* cf. *tenuicinctus* Hall, *Orthoceras bebryx* (?) Hall........................	505	1594
No. 6. This zone consists of a massive, grayish to slightly greenish-gray sandstone which breaks into quite large, irregular blocks and dips at an angle of 70°. Fossils are very rare in this sandstone; but specimens of *Spirifer* were found by Dr. Rowe.....	59	1653
This sandstone appears to the writer to represent the one which occurs at numerous other localities in the upper part of the Romney formation and the top of the sandstone is regarded as marking the upper limit of the Romney in this section. If this be true then the Romney formation has an approximate thickness of 1653 feet in the western part of Washington County which agrees closely with its thickness in Allegany County, 1590 feet, at Gilpin.		
No. 7. The remaining part of the section consists of thin, greenish shales alternating with thin bedded sandstones. The dips vary from 70° to 83° and the average of a number of readings is 75°. Succeeding the massive sandstone at the top of the Romney formation are thin greenish shales and there is no representation of the black Genesee shale. The layers of sandstone are thin, still there is a great deal of sandstone and it, possibly, forms nearly one-half of the thickness of the rocks. This zone is in the Jennings formation and, probably, all of it belongs in the Woodmont member	1257	2910

Exposures near Hancock.—The Romney is exposed on the National Road just east of Hancock. The following descriptions of the various zones of the section beginning with No. 1, at the top of the Romney, are from Dr. Rowe's notes:

	Thickness.	Total thickness.
No. 1. Cross and thin bedded light olive sandstone with little or no shale. Average dip 48°. Strike N. 25° E. Sandstone zone at the top of the Romney formation...........................	55½	388
No. 2. Layer with numerous specimens of *Camarotoechia*.......	½	332½
No. 3. Cross and thin bedded light olive sandstone with little or no shale..	72	332

	Thickness.	Total thickness.
No. 4. Bluish-gray shales with a band of calcareous sandstone near the top. This zone is fossiliferous. Average dip 60° E. Strike N. 35° E.	260	260

The shales in the small run at the east end of Hancock, just east of the Catholic Church furnished the following species: *Orbiculoidea* sp., *Stropheodonta* (*Leptostrophia*) *perplana* (Conrad), *Chonetes mucronatus* Hall, *Chonetes coronatus* (Conrad), *Chonetes scitulus* Hall, *Chonetes setiger* (Hall), *Chonetes lepidus* Hall, *Camarotoechia congregata* (Conrad), *Tropidoleptus carinatus* (Conrad), *Cyrtina hamiltonensis* Hall, *Spirifer mucronatus* (Conrad), *Spirifer granulosus* (Conrad), *Spirifer audaculus* (Conrad), *Spirifer tullius* Hall, *Ambocoelia umbonata* (Conrad), *Orthonota undulata* Conrad, *Pleurotomaria capillaria* Conrad, *Bellerophon* sp.

The following species were collected by Dr. Rowe on the road from Hancock to Harrisonville about 2 miles north of Hancock in the southern part of Fulton County, Pa.: *Stropheodonta* (*Leptostrophia*) *perplana* (Conrad), *Stropheodonta demissa* (Conrad), *Stropheodonta* cf. *concava* Hall (small specimen), *Schuchertella* sp., *Chonetes mucronatus* Hall, *Chonetes coronatus* (Conrad), *Chonetes scitulus* Hall, *Chonetes setiger* (Hall), *Camarotoechia congregata* (Conrad), *Tropidoleptus carinatus* (Conrad), *Cyrtina hamiltonensis* Hall, *Spirifer mucronatus* (Conrad), *Spirifer granulosus* (Conrad), *Spirifer audaculus* (Conrad), *Spirifer tullius* Hall, *Grammysia* cf. *circularis* Hall, *Nucula corbuliformis* Hall, *Palaeoneilo rowei* Prosser, *Palaeoneilo marylandica* Prosser, *Parallelodon hamiltoniae* (Hall), *Pterinea flabellum* (Conrad), *Aviculopecten princeps* (Conrad), *Modiomorpha concentrica* (Conrad), *Modiomorpha mytiloides* (Conrad) (?), *Goniophora hamiltonensis* Hall, *Pholadella radiata* (Conrad), *Cypricardella tenuistriata* (Hall), *Paracyclas lirata* Conrad, *Pleurotomaria* (*Bembexia*) *sulcomarginata* Conrad, *Pleurotomaria capillaria* Conrad, *Cyclonema hamiltoniae* Hall, *Platyceras erectum* Hall (?), *Homalonotus dekayi* (Green).

The following species were collected in the cut on the Baltimore and Ohio Railroad at Hancock station, on the West Virginia side of the Potomac River: *Stropheodonta* (*Leptostrophia*) *perplana* (Conrad), *Chonetes mucronatus* Hall, *Spirifer granulosus* (Conrad), *Spirifer auda-*

culus (Conrad), *Orthonota undulata* Conrad, *Pleurotomaria capillaria* Conrad (?), *Bellerophon* sp.

Exposure at Millstone.—At the western end of Millstone village is a blocky sandstone on the upper layers of which are good specimens of *Spirophyton velum* (Vanuxem). This sandstone is perhaps the one at the top of the Romney formation and is brought up at this locality by a small anticlinal fold. Along the road east of this point are olive, thin, micaceous shales, alternating with thin olive sandstones which dip about 40° S., 10° E., and are in the lower part of the Jennings formation. To the west of the anticline, the rocks dip westerly and soon expose the olive shales and sandstones in the lower part of the Jennings formation. No fossils were found in the Jennings shales in the village although, probably, more careful search would reveal some.

To the southeast of Millstone on the National Road about one-half mile west of Licking Creek are yellowish, very argillaceous shales, much spotted with red blotches from weathering, which contain *Tropidoleptus carinatus* (Conrad) in considerable abundance, *Spirifer mucronatus* (Conrad) and *Chonetes;* the complete list being as follows: *Chonetes mucronatus* Hall, *Chonetes setiger* (Hall), *Tropidoleptus carinatus* (Conrad), *Spirifer mucronatus* (Conrad), *Spirifer granulosus* (Conrad), *Spirifer audaculus* (Conrad), *Bellerophon* sp.

A little farther west, a zone of quite heavy, massive sandstone crosses the road which before weathering is grayish in color but afterwards has a brownish tint. It is strongly arenaceous and breaks into rather small blocks. A few fossils are to be found in it such as *Spirifer;* but they are rather infrequent. Some 8 feet of the rock is shown with a dip of 70° about N. For a few feet the rocks are covered, then coarse sandy shales appear and these in turn are followed by finer shales and then a sandstone stratum 1 foot in thickness. This is probably an outcrop of the upper sandstone of the Romney formation.

Exposure at Warren Point.—This outcrop occurs at the southern end of the iron bridge crossing Licking Creek, just over the state line in Pennsylvania, and a little more than 1 mile southeast of Warren Point. In the cliff on the southern side of the creek, a short distance to the west,

is the best exposure of the Helderberg formation in the Hancock region, showing the faunas of the Coeymans limestone, New Scotland beds and Becraft limestone of New York. This region has been well described by Dr. Rowe and he has also described the section at the southern end of the bridge, which is an especially interesting one as it shows the contact of the Oriskany and Romney with a conglomerate at the top of the Oriskany and another at the base of the Romney, and called attention to its structural significance. A more detailed section of this locality follows:

No. 1. On the bank at the eastern side of the bridge and along the side of the highway to the south the upper rocks of the Oriskany sandstone and the succeeding shales of the Romney formation are shown. Beginning at the top of the section these shales as shown by the roadside are somewhat arenaceous, rather coarser than the lower ones, weather to a slightly greenish tint and are in the Onondaga member. There are some fossils here and the following species have been identified: *Rhipidomella cyclas* Hall (?), *Ambocoelia umbonata* (Conrad), *Styliolina fissurella* (Hall), *Phacops rana* (Green), Crinoid segments.

No. 2. The lowest shales are argillaceous, weather to a slightly greenish tint and contain some quartz pebbles which were probably derived from the lower Oriskany conglomerate.

No. 3. Covered for some 2 to 3 inches; Romney-Oriskany contact.

No. 4. At the top of the Oriskany a layer of mainly rather coarse grained sandstone in which are some quartz pebbles.

No. 5. A conglomerate layer, 2½ inches in thickness, containing quite large, smooth, quartz pebbles some of which are 1½ inches in length and ¾ of an inch in width.

No. 6. Dark blue, arenaceous limestone in which are bands of grit containing some fair sized quartz pebbles, and conglomerate. Only the upper part of this zone, in which fairly abundant specimens of Oriskany fossils occur in layers, is shown on the eastern side of the bridge; but on the western side is a much better outcrop where between 14 and 15 feet is exposed. The grit and conglomerate layers are also better shown on the western side.

No. 7. Below the grit of the previous zone is dark blue limestone containing quite large masses of blackish chert. During low water 4 feet, 3 inches of this zone is shown to the level of Licking Creek.

The contact of the Oriskany and Romney is also shown in the abandoned quarry to the east of the bridge on the northern side of the creek. At the top of the Oriskany is a conglomeratic layer, with a thickness of 8 inches, in which are large and numerous quartz pebbles. Above this is a shaly layer containing a good many pebbles and this is regarded as a basal conglomerate of the Romney formation.

As has been already stated the conglomerate at the top of the Oriskany sandstone indicates shallow water and shore conditions which were probably followed by a land area. This land area evidently continued for a time preceding the formation of the Onondaga shale, when a subsidence occurred and the basal conglomerate of the Romney formation was deposited. The Warren Point conglomerates were discovered by Dr. Rowe who first called attention to the evidence of unconformity at this locality between the Oriskany and Romney formations. Farther southward, in Virginia, Darton described an erosional unconformity between the Monterey (Oriskany) and Romney formations, especially in the region to the west of Staunton.[1]

Exposure at Ernstville.—By the roadside in Ernstville, to the southeast of Licking Creek, are exposures of fine, blue shales which split irregularly and are quite arenaceous. They contain a considerable fauna composed of *Phacops rana* (Green), *Chonetes coronatus* (Conrad), and other species as listed below: *Stereolasma rectum* (Hall), *Heliophyllum* sp., *Orbiculoidea lodiensis* var. *media* Hall, *Craniella* sp., *Leptaena rhomboidalis* (Wilckens), *Chonetes coronatus* (Conrad), *Chonetes* cf. *scitulus* Hall, *Chonetes setiger* (Hall) (?), *Productella* (?) *schucherti* Prosser, *Rhipidomella* cf. *vanuxemi* Hall, *Rhipidomella cyclas* Hall (?), *Schizophoria striatula* (Schlotheim) (?), *Ambocoelia umbonata* (Conrad), *Ambocoelia praeumbona* Hall (?), *Nucleospira concinna* Hall, *Nucula corbuliformis* Hall, *Nuculites oblongatus* Conrad, *Parallelodon hamiltoniae* (Hall),

[1] Am. Geol., Vol. X, 1892, p. 16.

Pleurotomaria (*Bembexia*) *sulcomarginata* Conrad, *Pleurotomaria* (*Trepospira*) *rotalia* Hall (?), *Diaphorostoma lineatum* (Conrad), *Styliolina fissurella* (Hall), *Spyroceras crotalum* (Hall), *Spyroceras clarkei* Prosser, *Phacops rana* (Green), *Dalmanites marylandicus* Prosser.

Exposure at McCoys Ferry.—At McCoys Ferry to the west of the southern end of North Mountain and 4 miles southwest of Clear Spring is the most eastern outcrop of the Romney shales. The rocks are grayish and somewhat arenaceous and are exposed to best advantage by the side of the highway under the Western Maryland Railroad bridge. These shales are very fossiliferous containing large numbers of *Chonetes*, especially fine specimens of *Chonetes coronatus* (Conrad), *Spirifer mucronatus* (Conrad), *Tropidoleptus carinatus* (Conrad), *Cyrtina hamiltonensis* Hall, and other species as follows: *Stropheodonta* (*Leptostrophia*) *perplana* (Conrad), *Schuchertella variabilis* Prosser, *Chonetes mucronatus* Hall, *Chonetes coronatus* (Conrad), *Chonetes setiger* (Hall), *Chonetes lepidus* Hall, *Chonetes vicinus* (Castelnau), *Tropidoleptus carinatus* (Conrad), *Cyrtina hamiltonensis* Hall, *Spirifer mucronatus* (Conrad), *Spirifer granulosus* (Conrad), *Spirifer audaculus* (Conrad), *Spirifer acuminatus* (Conrad), *Spirifer angustus* Hall (?), *Palaeoneilo tenuistriata* Hall (?), *Tentaculites attenuatus* Hall.

In this exposure the lithology and fauna agree so closely with the typical Hamilton shales of New York that there seems to be no opportunity for any question concerning the correctness of this correlation.

In the immediate vicinity of McCoys Ferry, on the Chesapeake and Ohio Canal, is an interesting cliff of Tuscarora sandstone. There are exposures of blue, fairly arenaceous shales between the canal and the Western Maryland Railroad southwest of McCoys Ferry. The rocks are less fossiliferous than those at the Ferry but certain layers contain a fair number of species of brachiopods while pelecypods are more abundant than in the preceding zone. These outcrops are probably higher in the Romney formation than those at McCoys Ferry. The fauna is as follows: *Chonetes scitulus* Hall, *Chonetes setiger* (Hall), *Chonetes vicinus* (Castelnau), *Tropidoleptus carinatus* (Conrad), *Spirifer mucronatus* (Conrad), *Prothyris lanceolata* Hall, *Grammysia bisulcata* (Con-

rad); *Grammysia arcuata* (Conrad), *Nucula corbuliformis* Hall, *Nuculites oblongatus* Conrad, *Nuculites triqueter* Conrad, *Nuculites grabaui* Prosser, *Palaeoneilo constricta* (Conrad), *Palaeoneilo emarginata* (Conrad), *Palaeoneilo tenuistriata* (Conrad), *Leda diversa* Hall, *Nyassa arguta* Hall (?), *Aviculopecten princeps* (Conrad), *Paracyclas lirata* Conrad, *Pleurotomaria (Trepospira) rotalia* Hall (?), *Diaphorostoma lineatum* Conrad (?), *Tentaculites attenuatus* Hall, *Tentaculites bellulus* Hall, var. *potomacensis* Prosser, *Phacops rana* (Green).

On the road about one-fourth mile north of Green Spring Furnace the following species were collected: *Chonetes mucronatus* Hall, *Chonetes coronatus* (Conrad), *Chonetes lepidus* Hall, *Rhipidomella* sp., *Cyrtina hamiltonensis* Hall, *Tentaculites attenuatus* Hall.

CORRELATION OF THE MIDDLE DEVONIAN

ONONDAGA MEMBER [1]

The earlier students of the Middle Devonian believed that the Onondaga member and its equivalents were absent in Maryland and adjoining parts of Pennsylvania and West Virginia and referred the lower beds of the Romney to the Marcellus. Thus, Prosser, who made a critical study of the Romney of Maryland, stated that the Onondaga is absent in Maryland and that the Marcellus rests upon the eroded surface of the Oriskany.[2] This was also the view of O'Harra,[3] who described the geology of Allegany County, and of Rowe[4] and Schuchert.[5] Other students of the problem in adjoining areas arrived at the same conclusions.[6] Kindle, who discusses the question elsewhere in this volume, has recently shown[7] that the lower beds of the Romney differ faunally from the overlying strata and has called them the Onondaga member of the Romney formation, which term has been adopted by the U. S. Geological Survey.[8]

Before discussing the age of this member it will be helpful to review the conditions that exist in New York, which is the typical area. The Marcellus of New York was originally made to comprise the dark carbonaceous shales lying between the Onondaga and Hamilton. It included two limestones, the lower of which is known as the Goniatite and the upper as the Stafford limestone. Recently the Marcellus formation has

[1] Contributed by Charles K. Swartz.

[2] Prosser, C. S., Jour. Geol., vol. ix, 1900, p. 418, and discussion in ms. of Romney formation for present volume.

[3] O'Harra, C. C., Md. Geol. Survey, Geology of Allegany County, 1900, pp. 103, 160.

[4] Rowe, R. B., Devonian of Md. Ms. in library of Johns Hopkins Univ.

[5] Schuchert, Chas., Proc. U. S. Nat. Mus., vol. xxvi, 1903, p. 414.

[6] Darton, N. H., Amer. Geol., vol. x, 1892, p. 16; Stevenson, J. J., 2d Geol. Survey Penn., vol. T2, 1882, pp. 81-83; Ulrich, E. O., and Schuchert, Chas., Bull. N. Y. State Mus., No. 52, 1902, pp. 653-654.

[7] Bull. U. S. Geol. Survey, No. 508, 1912, pp. 35-38.

[8] U. S. Geol. Survey, Pawpaw-Hancock Folio, 1912, field edition, p. 75.

been subdivided into three parts by Clarke and Luther,[1] who have designated them the Marcellus shale, the Stafford limestone, and the Cardiff shale, corresponding to the lower shale, the upper limestone, and the upper shale respectively.

Clarke[2] has shown that the Onondaga and Marcellus do not represent strictly successive periods of time, but that the lower beds of the Marcellus were deposited contemporaneously with the upper beds of the Onondaga, limestone being formed to the west farther from the shore, while the clays were deposited simultaneously in the east nearer the shore. This was proved by tracing the Goniatite limestone westward until it finally merged with the upper bed of the Onondaga limestone due to the thinning and ultimate disappearance of the black shales which lie between it and the Onondaga, in central New York. In other words, the lower beds of the Marcellus and upper beds of the Onondaga are contemporaneous and represent not two periods of time, but two phases of sediments deposited simultaneously but under different conditions. It thus becomes impossible to speak of Marcellus time as successive to Onondaga time, precisely as it is impossible to distinguish Chemung from Catskill time.

The Goniatite limestone, which is the important horizon-marker, is distinguished by the presence of numerous goniatites, particularly *Agoniatites expansus,* which is its most diagnostic form. The latter species is sometimes said to occur both in the Onondaga and the Marcellus, but it is to be noted that these terms may signify only the same horizon. The Stafford limestone which occurs at a higher level in the Marcellus is characterized by the advent of numerous species of Hamilton affinities which mingle with those of earlier age. It thus becomes a suitable horizon for a formational division as proposed by Clarke.

It would not be surprising to find that the shales replace successively lower and lower limestone beds as we approach the shore line until a large part of the deposits of Onondaga time may be represented by shale. Such appears to be the case in Maryland.

[1] Bull. N. Y. State Mus., No. 63, 1902, p. 16.

[2] Clarke, J. M., Bull. N. Y. State Mus., No. 49, 1901, pp. 115-138.

The correlation of these sediments will now be considered, discussing first their faunal and stratigraphic relations and then their age. The fauna of the Onondaga member is rich both in species and individuals in the Maryland area, contrasting strikingly in this respect with that of the overlying Marcellus. The accompanying table shows the species that have been observed in the Onondaga member in Maryland and adjoining parts of West Virginia, and indicates their range in the New York section.

Four elements may be discriminated in this fauna, according to their habitat in the New York section, i. e., species found in black shale, in arenaceous shale, in the Marcellus limestones and in the Onondaga limestone.

Four species, *Liopteria lævis, Orbiculoidea lodiensis, Styliolina fissurella,* and *Bactrites aciculus,* which are among the most common species of the fauna, are also common in the black shale of the Marcellus of New York. The three last species are frequent in the Genesee in which similar shale recurs. Since such carbonaceous muds are known to occur in different formations it is possible that these species are not so diagnostic of a particular horizon as of a definite kind of sediment. Kindle, who holds this view, urges that they have little value for purposes of precise correlation. However, such weight as they possess is clearly in favor of the relation of the beds under consideration to the Marcellus shale of New York.

A second element of the fauna consists of 12 species that are found in the arenaceous shale of the Hamilton, as well as in the Marcellus, none of which are known in New York in beds older than the Marcellus. They constitute 46 per cent of the species significant for purposes of correlation and strongly suggest the close faunal relation of these beds to the Marcellus.

Reference has already been made to the impure limestone occurring in the Marcellus of New York in which *Agoniatites expansus* and *Bactrites aciculatus* are found, the former species occurring in such numbers that this bed has been called the Goniatite limestone. A very similar lime-

Onondaga Species	Oriskany	Schoharie	Onondaga	Marcellus	Hamilton	Genesee	Portage	Chemung
BRACHIOPODA								
Lingula cf. nuda Hall	..	..	..	..	+	..	..	..
Orbiculoidea lodienses var media Hall	..	..	..	+	+	..	..	..
Craniella hamiltoniae Hall	..	..	..	+	+	..	..	..
Pholidops cf. areolata Hall	..	..	+	..	..	..	..	..
Stropheodonta (Leptostrophia) perplana (Conrad)	..	+	+	+	+	..	..	..
Pholidostrophia pennsylvanica Kindle	..	..	..	..	..	..	..	..
Schuchertella variabilis Prosser	..	..	..	..	..	..	..	..
Leptaenisca australis Kindle	..	..	..	..	..	..	..	..
Chonetes mucronatus (Conrad)	..	..	+	+	+	..	..	..
Chonetes rugosus Kindle	..	..	..	..	..	..	..	..
Anoplea nucleata Hall	+	..	..	..	..	..	..	..
Strophalosia truncata (Hall)	..	..	..	+	+	..	..	..
Dalmanella lenticularis (Vanuxem)	..	..	+	?	..	..	..	..
Rhipidomella vanuxemi Hall	..	..	?	+	+	..	..	..
Rhipidomella cyclas Hall ?	..	..	.	+	+	..	..	..
Centronella cf. ovata Hall	..	..	+	..	..	..	..	..
Spirifer (Reticularia) fimbriatus (Conrad)	+	+	+	+	+	..	..	..
Nucleospira concinna Hall	..	+	+	+	+	.	..	..
Anoplotheca acutiplicata (Conrad)	..	..	+	..	..	..	..	..
Anoplotheca camilla (Hall)	..	..	+	+	..	..	..	..
PELECYPODA								
Panenka alternata Hall	..	..	+	..	..	..	..	..
Panenka cf. dichotoma Hall	..	+	..	..	..	..	..	..
Panenka obsolescens Kindle	..	..	..	..	..	..	..	..
Panenka cf. multiradiata Hall	..	..	+	..	..	..	..	..
Nucula corbuliformis Hall	..	..	..	+	+	..	+	..
Nuculites triqueter Conrad	..	..	..	+	+	..	+	..
Nuculites modulatus Kindle	..	..	..	..	..	..	..	..
Palaeoneilo constricta ? (Conrad)	..	..	..	+	+	..	+	+
Liopteria laevis Hall	..	..	..	+	+	..	..	
Aviculopecten equilatera (Hall)	..	..	..	+	..	..	..	..
Modiomorpha subalata (Conrad)	..	..	..	+	+	..	+	..
GASTROPODA								
Platyostoma cf. euomphaloides Conrad	..	.	..	..	+	..	..	..
Loxonema hamiltoniae Hall	..	..	..	+	+	..	..	..
PTEROPODA								
Styliolina fissurella (Hall)	..	..	..	+	+	+	+	..
Conularia cf. undulata Conrad	..	..	..	..	+	..	..	..
CEPHALOPODA								
Bactrites aciculatus (Hall)	..	..	..	..	+	..	..	..
Bactrites aciculus Hall	..	..	..	..	..	+	..	..
Agoniatites expansus (Vanuxem)	..	..	+	+	..	..	..	..
Parodiceras discoideum (Conrad)	..	..	..	+	+	..	..	.
TRILOBITA								
Cyphaspis cf. stephanophora Hall	..	..	+	..	..	..	..	..
Phacops cristata Hall	..	..	+	..	..	..	..	..
Phacops cristata var. pipa Hall	..	..	+	..	..	..	..	..
OSTRACODA								
Leperditia subrotunda ?	..	..	..	..	..	..	..	..
Bollia ungula Jones	..	..	..	..	..	..	..	..
Bollia obesa Ulrich	..	..	..	..	..	..	..	..

stone occurs in the beds under consideration and contains both *Agoniatites expansus* and *Bactrites aciculatus.* The former species is practically restricted to the horizon of the Goniatite limestone in New York.

A fourth element consists of 8 species that are confined to the Onondaga in New York, including *Anoplotheca acutiplicata* and several trilobites. The first-named species is so abundant indeed that this member may be called the zone of Anoplotheca acutiplicata. Two species also are known in New York in formations older than the Onondaga. The 10 Onondaga and pre-Onondaga species constitute 36 per cent of the species significant for correlation.

The question may be raised whether some species have especial value for purposes of correlation. The trilobites are highly plastic forms usually indicating geological horizons with considerable accuracy. The 3 species occurring in this fauna are restricted to the Onondaga in New York while a large number of trilobites found elsewhere in the fauna by Kindle suggest a close relationship of the beds to the Onondaga. The goniatites are also of high value for correlation because they are free swimming forms that underwent rapid changes. The two species that occur in this fauna are found in the Marcellus in New York, one being diagnostic of the Goniatite limestone, while the other occurs also in the Hamilton.

It is thus seen that there are two conspicuous elements in the fauna, one indicating a relationship to the Onondaga and the other to the Marcellus. Kindle, who has studied this fauna from New York to Tennessee, emphasizes the importance of the trilobites and other Onondaga elements of the fauna. Other observers would perhaps give weight to the later elements of the fauna, holding that the most significant species are the later migrants into the region.

The faunal relations may be summarized in the following table:

	Number
Total number of species and varieties	45
Species not possessing significance for correlation	17
Occurring in this fauna only	7
Occurring in the Onondaga and Marcellus	8
Relations not assured	2

	Number	Per Cent
Species possessing significance for correlation	28	
Occurring in New York only in the Onondaga or earlier formations	10	36
In Oriskany	1	3.5
In Schoharie	1	3.5
In Onondaga	18	29
Occurring in New York only in the Marcellus or later formations	17	64
In Marcellus	1	3.5
In Marcellus and Hamilton	12	46
In Genesee	1	3.5

This table shows the clearly preponderating relationship of the fauna as a whole to the Marcellus fauna of New York.

The stratigraphic relations indicate no less clearly an age earlier than the upper part, at least, of the Marcellus of New York. The Marcellus is characterized by *Liorhynchus limitare*, which may be considered its guide fossil both in New York and Maryland. The beds containing this species overlie the fauna under consideration in Maryland and the adjoining states, and also throughout the Appalachian region according to Kindle. The constancy of this position indicates that the Onondaga fauna of Maryland is older than the zone of *Liorhynchus limitare*.[1] Lithologically the fissile dark shales found in some of the lower beds of this member suggest the Marcellus while the other beds resemble the shale of the Hamilton.

The foregoing facts show that these deposits were laid down in a basin in which many Onondaga species were present, but after the advent of many other forms restricted in New York to the Marcellus and Hamilton,

[1] Prosser reported *L. limitare* from the lower beds of the Romney in a number of sections in Maryland, particularly at 21st Bridge and on the Williams Road 3½ miles southeast of Cumberland. Kindle who has since examined the same sections failed to find that species at the horizons indicated by Prosser.

Anoplotheca acutiplicata, which is thought by Kindle to be diagnostic of the Onondaga, is also reported by Weller from the Newfoundland Grit and the Monroe shales of New Jersey, both of which overlie the Onondaga limestone (Pal. N. J., vol. iii, 1903, pp. 105, 106). It is associated in the Monroe shales with *Tropidoleptus carinatus*. It is also reported by Prosser as occurring rarely in the Hamilton of Maryland.

and that they are faunally most closely related to the Marcellus. It is further evident that they are older than the zone of *Liorhynchus limitare* in Maryland.

The determination of the exact age of these beds is difficult since the principles of correlation of deposits of this type are not well established. It is evident that faunas that are successive in one area must frequently be contemporaneous elsewhere, since the advent of highly developed species immediately succeeding another fauna in one region indicates that both were in existence earlier in some other basin and hence were, for a time at least, coexistent. When therefore a mingling of the species of two such faunas is observed in a third area it is at times impossible to affirm their precise age with certainty.

The following methods of solution appear possible under such circumstances; the study of the direction of migration of the species and their relations to sediments and physical conditions, the emphasis of certain species rather than others in correlation, the determination of the relations of the fauna as a whole and correlation by some recognizable horizon.

The first of these methods appears the most decisive. Unfortunately knowledge of the necessary data is rarely obtainable in an early stage of the investigation so that while this method has been used with much success in the study of the Upper Devonian it does not appear to be conclusive here. Mr. Kindle has contributed a valuable discussion of this aspect of the problem in another part of the present volume.

The second method appears to lead to very different results accordingly as certain elements of the fauna are emphasized rather than others. If we assume that the Marcellus of Maryland may represent but a part of the Marcellus of New York, a possible assumption in view of the varying limits of that formation, then the beds under consideration may be of early Marcellus age. This view would accord not only with the fact, so often observed, that species of an earlier fauna may persist and become mingled with those of a later; but also with the presence of so large a number of species restricted to the Marcellus and later beds in New York. Indeed many students would not hestitate to assume that species observed in later faunas elsewhere are, in general, the latest immigrants

into such an association, and hence are entitled to peculiar weight in correlation. Although this conclusion may be uncertain, especially when, as in the present case, the sediments of the beds to be correlated are like those of the later and unlike those of the earlier formation, nevertheless it is believed that particular weight should be given to the species found elsewhere in later formations, as has been done in the reference of the Helderberg to the Devonian and the Richmond to the Silurian. If, on the contrary, it is assumed that the zone of *Liorhynchus limitare* represents approximately the same interval in New York and Maryland, then these beds are older than much of the Marcellus of New York and are synchronous, at least in part, with the Onondaga. This view, which is that of Kindle, is favored not only by the position of the beds below the Marcellus of Maryland, but also by the presence in them of so many species that are restricted to the Onondaga in New York, including such plastic forms as trilobites.

When the emphasis of certain elements of the fauna leads to divergent results particular weight may be attached to the relations of the fauna as a whole. This criterion indicates again a close relationship of the beds to the Marcellus, since it has been shown that over 60 per cent of the significant species occurring in them are restricted to the Marcelllus and later formations of New York. The entire argument leads to the conclusion that the beds are of early Marcellus age and also in part contemporaneous with the Onondaga.

The explanation of these facts may perhaps be found in the conditions shown to exist in New York, where the upper beds of the Onondaga are of the same age as the lower beds of the Marcellus, and hence their faunas are contemporaneous. In other words the beds under discussion may have been deposited when both the Onondaga and Marcellus faunas were coexistent in this area, a condition which would fully explain the mingling of the faunas in the same beds and especially the presence of such highly significant species as the Onondaga trilobites and the Marcellus goniatites. Thus while the limestones of the Onondaga were accumulating off-shore in New York dark shales were being deposited on shore in the Appa-

lachian province, species of Onondaga type invading and mingling with those of Marcellus type in the latter sediments. Upon the termination of the Onondaga, Marcellus species persisted in the east and the later shale deposits of New York and Maryland were formed. The difference between the faunas of the shales of New York and Maryland is to be explained by the differences of habitat, black muds prevailing in New York while more arenaceous clays were deposited in Maryland. The Maryland beds may also be older in part than the corresponding shale deposits of New York. This explanation would fully harmonize with the conditions shown by Clarke to exist in New York and would explain the undoubted fact that the sediments were laid down in Maryland in a basin occupied simultaneously by numerous species of both the Onondaga and Marcellus faunas.

Agoniatites expansus appears in largest numbers in the upper 50 feet of this member where it is associated with *Bactrites aciculatus* precisely as it occurs in the Goniatite limestone of New York, to which horizon the former species is essentially restricted in that State. The limestone is impure and argillaceous and also increases in thickness in the western sections as in New York, being best seen in Maryland at 21st Bridge. Although it is not possible to affirm with confidence that the Goniatite limestone is the same in Maryland and New York, nevertheless their resemblance is very suggestive and it is believed that they may represent the same horizon. If this is true then the upper beds represent the horizon of the top of the Onondaga of western New York and of the Goniatite limestone in the Marcellus of central New York, while the lower beds may be older than the base of the Marcellus of that State. It also seems possible that a hiatus may exist in the Maryland section as is suggested by the apparent unconformity at the top of the Oriskany. The suggested relations of the New York and Maryland sections are shown in the diagram on the following page.[1] It must be remembered, however, that the precise correlation is but tentative and is not regarded as proved.

[1] The figure illustrating the conditions in New York is taken from Clarke's discussion in Bull. N. Y. State Mus., No. 49, 1901, p. 137.

This interpretation seems to accord fully with the results given by Kindle elsewhere in this volume[1] and at the same time to explain the manifestly close faunal relationship of this member to the Marcellus of New York.

The propriety of applying the name Onondaga may be questioned. The lithological and faunal differences that separate the beds from the overlying Marcellus make it desirable to discriminate them by a distinctive term. In view of the marked contrast between them and the Onondaga limestone of New York, both in lithology and fauna, it is believed that it might have been fitting to give them a new name. They are, however,

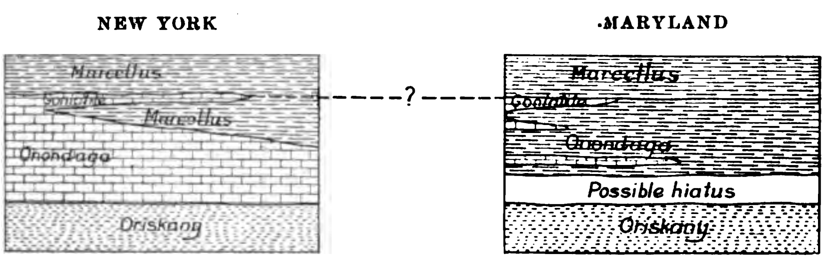

FIG. 1.—Diagram showing suggested relations between the Upper Devonian of Maryland and New York.

called the Onondaga member of the Romney in deference to the usage of the U. S. Geological Survey.

MARCELLUS MEMBER.[2]

The Marcellus member of the Romney formation has a very meager fauna, most of the strata being barren of organic remains. The species found, however, clearly show that it is to be correlated with part of the Marcellus of New York. The table on the following page gives a list of the species and indicates their range in the New York section.

One of these species is new. All of the remaining occur in the Marcellus of New York. Four species are found also in the Hamilton of New York while three pass into the Upper Devonian. Two species,

[1] See also Bull. U. S. Geol. Survey, No. 508, 1912.

[2] Contributed by Charles K. Swartz.

Liorhynchus limitare and *L. mysia* are especially diagnostic of the Marcellus.

Lithologically the sediments closely resemble the Marcellus shale of New York, consisting chiefly of dark or black, carbonaceous, fissile shale. Thin beds of limestone are also present as in the corresponding formation in New York, although this is a less conspicuous feature in the deposits of Maryland. These facts fully establish the Marcellus age of the beds.

The age of the blue fissile shales that lie between the strata containing the Marcellus fauna and the beds carrying the Hamilton fauna is open to question, no fossils having been observed in them up to the present.

Marcellus Species	Marcellus	Hamilton	Genesee	Portage
BRACHIOPODA				
Ambocoelia virginiana Prosser	..	..	..	..
Strophalosia truncata (Hall)	+	..	..	..
Camarotoechia prolifica Hall	+	+	..	..
Liorhynchus limitare (Vanuxem)	+	+	..	..
Liorhynchus cf. mysia Hall	+	..	..	..
PELECYPODA				
Buchiola restrostriata (Von Buch)	+	..	+	+
Nucula corbuliformis Hall	+	+	..	+
PTEROPODA				
Styliolina fissurella (Hall)	+	+	+	+

Prosser has included them in the Hamilton member, while Kindle refers them to the Marcellus member. Lithologically they probably resemble the Marcellus beds more closely than they do the overlying Hamilton shale which, in general, is not fissile, but blocky, and breaks into irregular, many-sided fragments.

HAMILTON MEMBER[1]

The rocks overlying the Marcellus shale of the Romney formation and extending northeasterly from northern West Virginia across Maryland and Pennsylvania to New York have been much more frequently corre-

[1] Contributed by Charles S. Prosser.

lated with the Hamilton beds of New York. Hall and other paleontologists have identified collections of fossils from these rocks in northern West Virginia and from intermediate localities between that state and New York as composed of Hamilton species. If the various geological maps, reports, and papers describing the Devonian formations from West Virginia to New York are put together and considered it will be found that this correlation is strongly supported by visible continuity. Furthermore the stratigraphic position of these beds strongly supports this correlation.

The paleontological data is much more extensive regarding the Hamilton beds than it is as yet for the Marcellus shale. The table of distribution gives the list of species recorded by the writer from the Hamilton beds of Maryland and their range in the New York formations. The total number of species is 147 of which 21 are limited to Maryland leaving 126 identical or closely related species which also occur in New York. An enumeration of the totals for the New York Devonian formations shows that 3 identical species occur in the Helderbergian series; 1 identical in the Oriskany; 6 identical in the Schoharie; 17 identical, doubtfully 4 more, and 2 affiliated occur in the Onondaga; 47 identical, 1 more doubtfully, and 7 affiliated in the Marcellus; 92 identical and 32 affiliated in the Hamilton; 2 identical in the Tully; 4 identical and 1 affiliated in the Genesee; 2 identical in the Portage; 4 identical and 2 affiliated in the Naples; 10 identical and 1 affiliated in the Sherburne; 55 identical, 2 more doubtfully, and 9 affiliated in the Ithaca, and 18 identical, 4 more doubtfully, and 3 affiliated in the Chemung. Adding these numbers, the total number of entries for each New York formation is as follows: Helderbergian series 3, Oriskany sandstone 1, Schoharie grit 6, Onondaga limestone 23, Marcellus shale 55, Hamilton beds 124, Tully limestone 2, Genesee shale 5, Portage beds 2, Naples beds 6, Sherburne sandstone 11, Ithaca beds 66, and the Chemung beds 25. Judging from the number of entries it is then seen that the Maryland beds show the closest relationship with the Onondaga, Marcellus, Hamilton, Ithaca, and Chemung formations of New York; and especially with the Marcellus, Hamilton, and Ithaca. On examining the total number of entries for these three formations it is

found that the Marcellus has 44.3 per cent as many as the Hamilton and the Ithaca 52.8 per cent. This is not remarkable, however, when it is recalled first, that a large percentage of the species in the Marcellus shale of New York continue into the Hamilton beds of that state, as has been shown by Clarke; second, the Ithaca fauna is sequential to the Hamilton and in the Ithaca region contains a large percentage of Hamilton species. When followed to the eastward and after the disappearance of the Tully limestone and Genesee shale in the Chenango Valley, the writer has shown that a still larger number of the Hamilton species lived into Ithaca time, although part of them were represented by simply a few individuals which were the last feeble representatives of their species. These rare individuals have been recorded in the range of the species making the faunas of the Hamilton and Ithaca beds of New York seem more closely related than they actually are and the same is true regarding the faunas of the Maryland beds and the Ithaca beds of New York. This explanation is sufficient to show that the table gives full expression to the closeness of the relationship which exists between the fauna of the Maryland beds and the faunas of the Marcellus shale and Ithaca beds of New York as compared with that which exists between the fauna of the Maryland beds and the New York Hamilton fauna. Restating the tabulation then, it is shown that there are more than twice as many entries common to the Maryland and New York Hamilton beds as to the Maryland and New York Marcellus; and nearly twice as many for the Maryland and New York Hamilton beds as for the Maryland and New York Ithaca. Therefore the paleontological evidence strongly supports the correlation of the Maryland beds, which represent in general the middle and upper portions of the Romney formation, with the Hamilton beds of New York.

An examination of the tables shows that the following number of species of the Hamilton beds of Maryland occur also in the formations of New York.

Number of species	occurring	in the	Onondaga	of N. Y.	17
"	"	"	Marcellus	"	47
"	"	"	Hamilton	"	92
"	"	"	Sherburne	"	10
"	"	"	Ithaca	"	55
"	"	"	Chemung	"	18

Recently H. S. Williams has published an extended account of what he calls the *Tropidoleptus carinatus* fauna of the Hamilton formation.[1] Faunally he considers the Hamilton formation as including the deposits between the top of the Onondaga limestone and the base of the Tully limestone of central New York, which have generally been divided into the Marcellus shale and the Hamilton beds. He writes as follows: "Faunally, the series of sediments, as they are exhibited in central New York (beginning at the top of the Onondaga (Corniferous) limestone and terminating at the base of the Tully limestone), presents a continuity which leaves no doubt as to the genetic succession of a common fauna from the base to the top. In dealing with this fauna, only the species between the limits of the top of the Onondaga limestone and the base of the Tully limestone, when these are present, will be considered as belonging typically to the *Tropidoleptus* fauna."[2] It will be seen, therefore, that these sediments represent what Dana called the Hamilton period, with the exception that they do *not* include the Tully limestone which, where it occurs, Dana apparently regarded as forming the top of this period;[3] that they correspond precisely with the Erian period or group of Clarke and Schuchert,[4] and also according to the writer's opinion, with the Marcellus and Hamilton members of the Romney formation of West Virginia and Maryland. Cleland in his "Study of the fauna of the Hamilton formation of the Cayuga Lake section in central New York" has also limited the Hamilton formation as indicated above, stating that "It is bounded above by the Tully and below by the Onondaga (Corniferous) limestone."[5]

Williams carefully tabulated the faunal lists of several students of the Hamilton formation, as defined above, and from those of the writer

[1] Amer. Jour. Sci., 4th Ser., Vol. XIII, 1902, pp. 421-432. U. S. Geol. Surv., Bull. No. 210, 1903, pp. 42-68.

[2] *Ibid.*, p. 50.

[3] Man. of Geol., 4th Ed., 1895, pp. 576, 593.

[4] Science, N. S., Vol. X, Dec. 15, 1899, pp. 876, 877. Univ. of the State of New York, Handbook 19, July, 1903, pp. 8, 22, 23.

[5] U. S. Geol. Surv., Bull. No. 206, 1903, p. 20.

prepared a table giving the 12 species occurring most frequently in it in eastern New York, another from the lists of Dr. Cleland giving the 14 most frequent species in the Cayuga Lake region, and a third from the lists of Grabau giving the 12 most frequent species from Eighteen Mile Creek in western New York. From these three tables another one was compiled by Williams which he called the "*Tropidoleptus* fauna: Standard list of dominant species for the New York-Ontario province." He furthermore stated that it was concluded on balancing up the various kinds of evidence that this list "contains the 12 most characteristic species of this fauna as it appears in the New York province, and shows the order of approximate rank they occupy in the fauna as a whole."[1] The 12 species composing this standard dominant list for New York is as follows:

1. **Spirifer pennatus (= mucronatus).**
2. **Phacops rana.**
3. **Tropidoleptus carinatus.**
4. **Ambocoelia umbonata.**
5. **Athyris spiriferoides.**
6. **Palaeoneilo constricta.**
7. **Spirifer granulosus.**
8. **Chonetes coronatus.**
9. **Nuculites triqueter.**
10. **Nucula corbuliformis.**
11. **Nuculites oblongatus.**
12. **Nucula bellistriata.**[2]

By reference to the Maryland lists it will be found that every one of the 12 species mentioned above as constituting the standard dominant list of the New York Hamilton is found in the Hamilton beds of Maryland.

Furthermore, Williams prepared another table by adding to the standard list the distributional value of all the species reported by Prosser in 37 faunules of the Unadilla region, that were not considered in the standard list, which he called a "Revised list of dominant species of the Hamilton formation of eastern New York and Pennsylvania, as

[1] *Loc. cit.*, p. 61.
[2] *Ibid.*, p. 60.

expressed in 183 faunules." This list contains the 12 species given in the standard one and the following four additional ones:

13. **Liorhynchus laura.**
14. **Paracyclas lirata.**
15. **Chonetes scitulus.**
16. **Stropheodonta perplana.**

These four additional species likewise occur in the Hamilton beds of Maryland.

The above review of the paleontological evidence shows conclusively the extension of the New York Hamilton as far southwest in the Appalachian basin as Maryland and the northern part of West Virginia.

Professor Williams after an examination of the preliminary lists from the Hamilton beds of Maryland arrived at essentially the same conclusion which he stated in the following paragraph:

"In the list furnished me by Professor Prosser there appear 132 entries, 91 of which are positive identifications. Among the latter are found all of the dominant species of the Tropidoleptus carinatus fauna, as estimated from the New York statistics. This is sufficient to establish the extension of the Tropidoleptus fauna, in its integrity, as far south in the Appalachian trough as Maryland."[1]

Other facts brought out in this report by Clarke, Swartz, and the writer, apparently show that the Hamilton beds of Maryland are succeeded by deposits and faunas similar to those succeeding the Hamilton of New York and therefore it may be concluded that the deposits of the Hamilton beds from New York to West Virginia were brought to a close at about the same geological time.

GEOLOGICAL DISTRIBUTION OF SPECIES.

The geological range in New York and Maryland of the Middle Devonian species listed in this volume is given in the tables of distribution. The following seven species, viz.: *Orthonota undulata* Conrad, *Palaeoneilo clarkei* Prosser, *Cyclonema* (?) *marylandense* Prosser, *Orthoceras*

[1] U. S. Geol. Surv., Bull. No. 210, 1903, p. 67.

subulatum Hall (?), *Orthoceras telamon* Hall (?), *Orthoceras emaceratum* Hall (?), and *Spyroceras nuntium* Hall were found only in West Virginia but on account of the nearness of their occurrence to the Maryland areas they have been left in the Maryland fauna. A complete list of occurrences for each species will be found in the part devoted to the systematic paleontology.

The geological range of the species in Maryland is compared with that of New York State, since the latter is the standard for the American Devonian and it is desired to learn with which New York formation the fauna of the Maryland Romney is most closely related. Again, where the age of the beds in certain districts of New York is in question the reported occurrence of species in such localities has not been recorded. For example, the species are not listed in these tables which have been reported in the fossiliferous beds immediately succeeding the Oneonta sandstone in the Chenango Valley and to the eastward, because they have been referred to the Chemung by some geologists and to the Ithaca by others. In reference to the Ithaca fauna in eastern central New York it must be remembered that it is composed largely of Hamilton species; but it is to be noted in reference to many of the species that they occur infrequently and not in the abundance which characterizes their distribution in the Hamilton.

GEOLOGICAL RANGE OF MIDDLE DEVONIAN SPECIES IN MARYLAND AND NEW YORK.

	SPECIES	Maryland: Lower Devonian	Maryland: Middle Devonian Romney: Onondaga Member	Maryland: Middle Devonian Romney: Marcellus Member	Maryland: Middle Devonian Romney: Hamilton Member	Maryland: Upper Devonian Jennings: Genesee Member	Maryland: Upper Devonian Jennings: Woodmont Member: Naples Fauna	Maryland: Upper Devonian Jennings: Woodmont Member: Ithaca Fauna	Maryland: Upper Devonian Jennings: Parkhead Member	Maryland: Upper Devonian Jennings: Chemung Member	New York: Lower Devonian	New York: Middle Devonian: Schoharie	New York: Middle Devonian: Onondaga	New York: Middle Devonian: Marcellus	New York: Middle Devonian: Hamilton	New York: Upper Devonian: Genesee	New York: Upper Devonian: Portage: Sherburne	New York: Upper Devonian: Portage: Ithaca	New York: Upper Devonian: Portage: Enfield	New York: Upper Devonian: Chemung
	CŒLENTERATA.																			
1	Stereolasma rectum (Hall)				*										*					
2	Cf. Amplexus hamiltoniæ Hall				*										*					
3	Heliophyllum sp.				*															
4	Cystiphyllum americanum Milne-Edwards & Haime				*										*					
	VERMES.																			
5	Polygnathus sp.		*																	
	MOLLUSCOIDEA—BRYOZOA.																			
6	Rhopalonaria tenuis Ulrich & Bassler				*										*					
7	Monticulipora (?) marylandensis Ulrich & Bassler.				*															
	MOLLUSCOIDEA—BRACHIOPODA.																			
8	Lingulella (?) paliformis Hall				*										*					
9	Lingula delia Hall (?)				*										*					
10	Lingula ligea Hall (?)				*			*						*	*					
11	Lingula cf. nuda Hall		*												*					
12	Lingula cf. compta Hall & Clarke				*										*					
13	Lingula clarki Prosser				*															
14	Orbiculoidea lodiensis var. media Hall				*				*					*	*					
15	Craniella hamiltoniæ Hall		*		*				*	*				*	*	*		*	*	
16	Pholidops hamiltoniæ Hall				*									*	*			*		
17	Pholidops cf. areolata Hall		*										*							
18	Stropheodonta (Leptostrophia) perplana (Conrad).		*		*							*	*	*	*			*		*
19	Stropheodonta demissa (Conrad)				*			*		*			*		*			*		*
20	Stropheodonta (Douvillina) inequistriata (Conrad)				*								*	*	*					
21	Stropheodonta concava Hall				*								*		*					
22	Pholidostrophia pennsylvanica Kindle		*																	
23	Leptæna rhomboidalis (Wilckens)				*								*					*		
24	Leptænisca australis Kindle		*																	
25	Schuchertella variabilis Prosser		*																	
26	Chonetes mucronatus Hall		*		*								*	*	*					
27	Chonetes coronatus (Conrad)				*									*	*			*		
28	Chonetes scitulus Hall				*									*	*			*		*
29	Chonetes setiger (Hall)				*									*	*			*		*
30	Chonetes lepidus Hall				*									*	*		*	*		*
31	Chonetes vicinus (Castelnau)				*										*			*		
32	Chonetes marylandicus Prosser				*															
33	Chonetes rugosus Kindle		*																	
34	Anoplia nucleata Hall		*								*									
35	Strophalosia truncata (Hall)		*	*	*									*	*			*		
36	Productella cf. spinulicosta Hall				*										*					
37	Productella (?) schucherti Prosser				*															
38	Dalmanella lenticularis (Vanuxem)		*										*	*						
39	Rhipidomella vanuxemi Hall		*		*				*	*			†	*	*			*	*	*
40	Rhipidomella leucosia Hall				*										*					
41	Rhipidomella penelope Hall				*										*					
42	Rhipidomella cyclas Hall (?)		*		*									*	*					
43	Schizophoria striatula (Schlotheim) (?)				*			*	?	†								*		*

† = related form.

GEOLOGICAL RANGE OF MIDDLE DEVONIAN SPECIES IN MARYLAND AND NEW YORK.—Continued.

	SPECIES	Maryland: Lower Devonian	Maryland: Middle Devonian Romney: Onondaga Member	Maryland: Middle Devonian Romney: Marcellus Member	Maryland: Middle Devonian Romney: Hamilton Member	Maryland: Upper Devonian Jennings: Genesee Member	Maryland: Upper Devonian Jennings: Woodmont Member: Naples Fauna	Maryland: Upper Devonian Jennings: Woodmont Member: Ithaca Fauna	Maryland: Upper Devonian Jennings: Parkhead Member	Maryland: Upper Devonian Jennings: Chemung Member	New York: Lower Devonian	New York: Middle Devonian: Schoharie	New York: Middle Devonian: Onondaga	New York: Middle Devonian: Marcellus	New York: Middle Devonian: Hamilton	New York: Upper Devonian: Genesee	New York: Upper Devonian: Portage: Sherburne	New York: Upper Devonian: Portage: Ithaca	New York: Upper Devonian: Portage: Enfield	New York: Upper Devonian: Chemung
	MOLLUSCOIDEA—BRACHIOPODA.—Continued.																			
44	Camarotœchia congregata (Conrad)	..	..	..	*	..	..	..	†	†	..	..	..	..	*	..	..	*	..	*
45	Camarotœchia prolifica Hall	..	..	*	*	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..
46	Camarotœchia sappho Hall	..	..	..	*	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..
47	Camarotœchia sp.	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
48	Liorhynchus limitare (Vanuxem)	..	..	*	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..
49	Liorhynchus laura (Billings)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
50	Liorhynchus cf. mysia Hall	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..
51	Centronella cf. ovata Hall	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..
52	Eunella lincklæni Hall	..	..	..	*	..	..	..	..	..	..	..	..	*	*	..	..	*	..	..
53	Tropidoleptus carinatus (Conrad)	..	..	..	*	..	..	..	*	*	..	..	..	*	*	..	..	*	*	*
54	Atrypa reticularis (Linné)	..	..	..	*	..	..	*	*	*	..	..	*	..	*	..	..	*	*	*
55	Cyrtina hamiltonensis Hall	..	..	..	*	..	..	*	*	*	..	..	*	..	*	..	*	*	..	*
56	Spirifer mucronatus (Conrad)	..	..	..	*	..	..	†	?	..	..	..	..	*	*	..	..	*	..	..
57	Spirifer granulosus (Conrad)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	*	..	..
58	Spirifer audaculus (Conrad)	..	..	..	*	..	..	..	..	..	..	..	..	*	*	..	..	*	..	..
59	Spirifer acuminatus (Conrad)	..	..	..	*	..	..	..	..	..	..	..	*	..	*	..	..	..	..	..
60	Spirifer tullius Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	*	..	..
61	Spirifer angustus Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	*	..	..
62	Spirifer (Reticularia) fimbriatus (Conrad)	..	*	..	*	..	..	..	..	..	*	*	*	*	*	..	..	*	..	*
63	Spirifer cf. consobrinus (d'Orbigny)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
64	Spirifer sculptilis var. marylandensis Prosser	..	..	..	*	..	..	..	..	..	..	..	..	..	†	..	..	..	..	..
65	Ambocœlia umbonata Conrad	..	..	..	*	..	..	..	*	*	..	..	..	*	*	..	?	*	*	*
66	Ambocœlia virginiana Prosser	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
67	Ambocœlia præumbona Hall (?)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
68	Nucleospira concinna Hall	..	*	..	*	..	..	..	..	..	..	*	*	*	*	..	..	..	..	..
69	Anoplotheca (Cœlospira) acutiplicata (Conrad)	..	*	..	*	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..
70	Anoplotheca camilla (Hall)	..	*	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..
71	Vitulina pustulosa Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
72	Athyris spiriferoides (Eaton)	..	..	..	*	..	..	..	..	..	..	..	*	*	*	..	..	*	..	..
73	Meristella ? sp.	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	MOLLUSCA—PELECYPODA.																			
74	Phthonia sectifrons (Conrad)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
75	Phothyris lanceolata Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	*	..	..
76	Orthonota undulata Conrad	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
77	Orthonota (?) parvula Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	*	..	..
78	Grammysia bisulcata (Conrad)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	*	..	..
79	Grammysia arcuata (Conrad)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	*	..	..
80	Grammysia sp.	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
81	Grammysia circularis Hall (?)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
82	Euthydesma sp.	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
83	Tellinopsis subemarginata (Conrad)	..	..	..	*	..	..	..	..	..	..	..	..	*	*	..	..	*	..	..
84	Panenka alternata Hall	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..
85	Panenka cf. dichotoma Hall	..	*	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..
86	Panenka obsolescens Kindle	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
87	Panenka cf. multiradiata Hall	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..
88	Buchiola retrostriata von Buch	..	..	*	..	*	*	..	..	..	..	..	..	*	..	*	*	..	..	..
89	Buchiola halli Clarke	..	*	..	*	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..
90	Nucula corbuliformis Hall	..	..	*	*	..	..	*	*	*	..	..	..	*	*	..	*	*	..	*
91	Nucula bellistriata (Conrad)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	*	..	..
92	Nucula lirata (Conrad)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	*	..	..
93	Nucula varicosa Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..

† = related form.

GEOLOGICAL RANGE OF MIDDLE DEVONIAN SPECIES IN MARYLAND AND NEW YORK.—Continued.

	SPECIES	Maryland: Lower Devonian	Maryland: Middle Devonian Romney: Onondaga Member	Maryland: Middle Devonian Romney: Marcellus Member	Maryland: Middle Devonian Romney: Hamilton Member	Maryland: Upper Devonian Jennings: Genesee Member	Maryland: Upper Devonian Jennings: Woodmont Member: Naples Fauna	Maryland: Upper Devonian Jennings: Woodmont Member: Ithaca Fauna	Maryland: Upper Devonian Jennings: Parkhead Member	Maryland: Upper Devonian Jennings: Chemung Member	New York: Lower Devonian	New York: Middle Devonian: Scholarie	New York: Middle Devonian: Onondaga	New York: Middle Devonian: Marcellus	New York: Middle Devonian: Hamilton	New York: Upper Devonian: Genesee	New York: Upper Devonian: Portage: Sherburne	New York: Upper Devonian: Portage: Ithaca	New York: Upper Devonian: Portage: Enfield	New York: Upper Devonian: Chemung
	MOLLUSCA—PELECYPODA.—Continued.																			
94	Nuculites oblongatus Conrad	..	..	..	•	..	..	..	..	..	..	..	..	•	•	..	•	..	..	..
95	Nuculites triqueter Conrad	..	•	..	•	..	..	..	..	..	..	..	..	•	•	..	..	•	..	..
96	Nuculites grabaui Prosser	..	..	..	•	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
97	Nuculites modulatus Kindle	..	•	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
98	Palæoneilo constricta (Conrad)	..	•	..	•	..	..	•	..	•	..	..	..	•	•	..	•	•	..	•
99	Palæoneilo plana Hall	..	..	..	•	..	..	•	•	•	..	..	..	..	•	..	•	•	•	•
100	Palæoneilo maxima (Conrad) (?)	..	..	..	•	..	..	..	•	..	..	..	..	..	•	..	..	•	..	..
101	Palæoneilo fecunda Hall	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	•	..	..
102	Palæoneilo perplana var. grabaui Prosser	..	..	..	•	..	..	..	..	..	..	..	..	..	†	..	..	..	..	..
103	Palæoneilo emarginata (Conrad)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	•	..	..
104	Palæoneilo tenuistriata Hall (?)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	..	..	..
105	Palæoneilo clarkei Prosser	..	..	..	•	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
106	Palæoneilo rowei Prosser	..	..	..	•	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
107	Palæoneilo marylandica Prosser	..	..	..	•	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
108	Tancrediopsis clarkei Prosser	..	..	..	•	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
109	Leda diversa Hall	..	..	..	•	..	..	..	•	•	..	..	..	..	•	..	•	•	..	..
110	Leda rostellata (Conrad)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	..	..	..
111	Parallelodon hamiltoniæ (Hall)	..	..	..	•	..	..	..	..	..	..	..	..	•	•	..	..	•	..	•
112	Pterinea flabellum (Conrad)	..	..	..	•	..	..	..	..	..	..	..	•	..	•	..	..	..	..	•
113	Liopteria cf. conradi Hall	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	..	..	..
114	Liopteria lævis Hall	..	•	..	..	..	..	..	..	..	..	..	..	•	•	..	..	..	..	..
115	Leptodesma rogersi Hall	..	..	..	•	..	..	..	..	•	..	..	..	..	•	..	•	•	•	•
116	Mytilarca (Plethomytilus) oviformis (Conrad)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	..	..	..
117	Conocardium normale Hall	..	..	..	•	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
118	Conocardium cumberlandiæ Swartz	..	..	..	•	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
119	Actinopteria decussata Hall	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	..	..	..
120	Actinopteria boydi var. gibbosa Prosser	..	..	..	•	..	..	†	..	..	..	..	..	..	†	..	..	†	..	..
121	Actinopteria sp.	..	..	..	•	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
122	Modiella pygmæa (Conrad)	..	..	..	•	..	..	..	..	..	..	..	..	•	•	..	..	•	..	..
123	Nyassa arguta Hall (?)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	..	..	..
124	Aviculopecten princeps (Conrad)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	..	..	..
125	Aviculopecten equilatera (Hall)	..	•	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
126	Modiomorpha concentrica (Conrad)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	•	..	..
127	Modiomorpha subalata (Conrad)	..	•	..	•	..	..	..	..	..	..	..	..	•	•	..	•	•	..	..
128	Modiomorpha mytiloides (Conrad) (?)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	..	..	..
129	Goniophora hamiltonensis Hall	..	..	..	•	..	..	•	•	..	..	..	..	..	•	..	..	•	..	•
130	Pholadella radiata (Conrad)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	•	..	..
131	Cypricardella bellistriata (Conrad)	..	..	..	•	..	..	..	•	..	..	..	..	•	•	..	..	•	•	•
132	Cypricardella tenuistriata (Hall)	..	..	..	•	..	..	..	•	•	..	..	..	..	•	..	..	•	..	..
133	Cypricardinia indenta (Conrad)	..	..	..	•	..	..	..	..	..	..	..	•	•	•	..	..	..	..	..
134	Paracyclas lirata Conrad	..	..	..	•	..	..	..	..	..	..	..	..	•	•	..	..	•	..	..
135	Paracyclas tenuis Hall	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	•	..	..
136	Palæosolen minutus Prosser	..	..	..	•	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	MOLLUSCA—GASTROPODA.																			
137	Pleurotomaria (Bembexia) sulcomarginata Conrad	..	..	..	•	..	..	..	..	..	..	..	•	•	•	..	..	•	..	..
138	Pleurotomaria (Gyroma) capillaria Conrad	..	..	..	•	..	..	..	•	..	..	..	..	•	•	..	•	•	•	•
139	Pleurotomaria (Trepospira) rotalia Hall (?)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	..	..	..
140	Pleurotomaria (Euryzone) itys Hall (?)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	..	..	..
141	Bellerophon (Bucanopsis) leda Hall	..	..	..	•	..	..	..	..	..	..	..	..	•	•	..	..	•	..	..
142	Bellerophon (Patellostium) patulus Hall (?)	..	..	..	•	..	..	..	..	..	..	..	..	..	•	..	..	..	..	..
143	Cyrtolites (Cyrtonella) mitella Hall	..	..	..	•	..	..	..	..	..	..	..	..	•	•	..	..	..	..	..

† = related form.

GEOLOGICAL RANGE OF MIDDLE DEVONIAN SPECIES IN MARYLAND AND NEW YORK.—Continued.

	SPECIES	Maryland									New York									
			Middle Devonian Romney			Upper Devonian Jennings						Middle Devonian				Upper Devonian				
							Woodmont Member										Portage			
		Lower Devonian	Onondaga Member	Marcellus Member	Hamilton Member	Genesee Member	Naples Fauna	Ithaca Fauna	Parkhead Member	Chemung Member	Lower Devonian	Schoharie	Onondaga	Marcellus	Hamilton	Genesee	Sherburne	Ithaca	Enfield	Chemung
	MOLLUSCA—GASTROPODA.—Continued.																			
144	Cyclonema hamiltoniæ Hall (?)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
145	Cyclonema liratum var. grabaui Prosser	..	..	..	*	..	..	..	..	†	..	..	..	..	†	..	..	..	..	..
146	Cyclonema (?) marylandense Prosser	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
147	Naticopsis sp.	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
148	Macrochilus hamiltoniæ Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
149	Loxonema hamiltoniæ Hall	..	*	..	*	..	..	..	*	..	..	..	..	*	*	..	..	..	..	..
150	Platyceras erectum Hall (?)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
151	Platyceras cf. symmetricum Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
152	Diaphorostoma lineatum (Conrad)	..	..	..	*	..	..	..	..	*	..	..	*	*	*	..	..	..	..	..
153	Platyostoma cf. euomphaloides Conrad	..	*	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
154	Styliolina fissurella (Hall)	..	*	*	*	*	..	..	..	..	..	..	..	*	*	*	*	*	..	..
155	Tentaculites attenuatus Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
156	Tentaculites bellulus Hall	..	..	..	*	..	..	..	..	..	..	..	..	*	*	..	..	*	..	..
157	Tentaculites bellulus var. potomacensis Prosser	..	..	..	*	..	..	..	..	..	..	..	..	†	†	..	..	..	..	..
158	Conularia cf. undulata Conrad	..	*	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
159	Enchostoma ? sp	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
160	Coleolus tenuicinctus Hall	..	..	..	*	..	..	..	*	*	..	..	..	..	*	..	..	*	..	..
	MOLLUSCA—CEPHALOPODA.																			
161	Orthoceras bebryx Hall (?)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
162	Orthoceras subulatum Hall (?)	..	..	..	*	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..
163	Orthoceras constrictum Vanuxem	..	..	..	*	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..
164	Orthoceras cf. exile Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
165	Orthoceras telamon Hall (?)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
166	Orthoceras emaceratum Hall (?)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
167	Orthoceras cf. aulax Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
168	Spyroceras crotalum (Hall)	..	..	..	*	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..
169	Spyroceras nuntium Hall	..	..	..	*	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..
170	Spyroceras clarkei Prosser	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
171	cf. Gomphoceras pingue Hall	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
172	Bactrites aciculatus (Hall)	..	*	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..
173	Bactrites aciculus Hall	..	*	..	..	*	..	..	..	..	..	..	..	..	..	*	*	*	*	*
174	Agoniatites expansus (Vanuxem)	..	*	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..
175	Parodiceras discoideum (Conrad)	..	*	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..	..
	ARTHROPODA.																			
176	Cyphaspis cf. stephanophora Hall	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..
177	Homalonotus dekayi (Green)	..	..	..	*	..	..	..	..	..	..	..	..	*	*	..	..	*	..	..
178	Phacops rana (Green)	..	..	..	*	..	..	..	*	..	..	..	..	*	*	..	..	*	*	*
179	Phacops cristata Hall	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..
180	Phacops cristata var. pipa Hall	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..
181	Dalmanites (Cryphæus) boothi (Green)	..	..	..	*	..	..	..	..	..	..	..	..	*	*	..	..	*	..	..
182	Dalmanites marylandicus Prosser	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
183	Leperditia ? cf. subrotunda Ulrich	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
184	Bollia ungula Jones	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
185	Bollia obesa Ulrich	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

† = related form.

RELATIONS OF THE FAUNAS TO SEDIMENTS [1]

It has been supposed until recently that the Onondaga sediments and fauna were absent from Maryland. This view prevailed generally until the writer [2] found that the Onondaga fauna could be traced southwestward from eastern New York across eastern and central Pennsylvania into Maryland. In passing across the State of Pennsylvania many of the species which characterize the Onondaga limestone fauna of New York are found to drop out and to be replaced by others which are unknown in New York. Hence it is not at all surprising that the geologists who have studied the fauna found in the lower part of the Romney of Maryland, without having an opportunity to compare it with the fauna of the same horizon in Pennsylvania but intermediate in facies between the Onondaga fauna of Maryland and that of New York, failed to recognize it as the equivalent of the latter fauna. The commonly accepted belief in a high degree of uniformity in the character of the Onondaga and Hamilton faunas throughout the eastern part of America has also militated strongly against the recognition of the basal fauna of the Romney of Maryland as a provincial Onondaga fauna. This preconception has influenced the judgment of stratigraphers and paleontologists alike. The latter have expected formations and the former faunas to show about the same characteristics in the middle Alleghany region which they do in New York. The great provincial differences which the work of several geologists has demonstrated to characterize Upper Devonian faunas which lived in different parts of the same sea have been assumed to be peculiar to the late Devonian and not common to the Middle and Lower Devonian. This generally accepted view has been formulated by one geologist in the following statement:

"During Upper Devonian time the faunas of the Eastern Continental Province were far more local in their development than they had been at any time during the Middle Devonian. At no time during the period was there so uniform a fauna as either the Onondaga or the Hamilton had been, distributed through the entire province."

[1] Contributed by Edward M. Kindle.
[2] Bull. U. S. Geol. Survey, No. 508, 1912.

The writer's unpublished work on the Hamilton stratigraphy of Virginia indicates that distinct faunal facies existed during Hamilton time in that region that showed even greater contrasts than those which characterize the Portage faunas of eastern and western New York. Extended studies by the writer of the local peculiarities of various other Devonian faunas have convinced him that the rather sharp contrasts between the Onondaga fauna of Maryland and that of New York are in no sense anomalous, but represent regional and bathymetric differences in the same fauna. It is quite as important in Devonian as in Tertiary formations that stratigraphic paleontology should be studied and interpreted "by the combined aid of the laws of geographical distribution and of the bathymetric arrangement of marine animals and of sedimentary matter."

It may be profitable to call attention here to some of the fundamental factors which tend to develop different types of a fauna in different parts of the same sea at present and which operated in about the same manner in the Paleozoic seas. The surprising influence of local environment in producing great variation in the kind, variety, and abundance of marine life along different parts of the same coast in our present seas is a fact which paleontologists are prone to overlook. Concerning the scarcity of marine life along certain portions of the British coast one naturalist writes, "I have dredged along a bank of this kind for 30 miles on our own coast without finding a single living form."[1] In marked contrast with this barren stretch of sea bottom we find other tracts along the same coast tenanted with a marvelous abundance of life. Just outside the estuary of the river Mersey in Lancashire, Johnstone reports the average results of several hundred hauls in this portion of the British sea as follows: "Thus the total number of animals captured per haul was about 12,000 and very often much larger catches than this were made."[2]

It does not appear that depth was a factor in producing the very great contrasts in the abundance of life in these two areas of the same sea. They were due chiefly, if not entirely, to different types of sea bottom and

[1] Goodwin-Austin: Natural History of the European Seas, 1859, p. 233.

[2] Johnstone, Jas.: Conditions of life in the sea, 1908, p. 176.

to differences in food supply. These two factors were undoubtedly as potent in their influence on marine life during Middle Devonian time as they are to-day. In most seas, however, the bathymetric principle is also a factor in governing the abundance and variety of marine life; this principle is conspicuously operative in going seaward from a coast line and is an important factor in determining the off-shore and more pelagic peculiarities of a fauna. With regard to the influence of depth or the bathymetric factor on a fauna the concise statement of Goodwin-Austin is well worth quoting here. He writes: "The sublittoral zone of every sea and ocean presents the fullness of its fauna and from that it decreases progressively and rapidly."[1] If we bear in mind the possibility, or rather the certainty, of provincial features or differences of very pronounced character appearing in the same fauna whenever marked changes arise in the character of the sedimentation, food supply, or depth it will be easy to understand why the fauna which will be described in succeeding pages differs in some important details from the Onondaga fauna as it is found in New York. The Tully limestone fauna of New York affords an excellent Devonian example of the change in the character of a fauna with change in type of sediment.

This limestone which lies between the Genesee and Hamilton formations covers a considerable area in central New York but thins toward the east and toward the west of the region of its maximum development and ultimately disappears as a recognizable formation both in eastern and western New York. Prosser[2] has shown that at the Tully horizon in eastern New York after the limestone has disappeared only one or two of the characteristic Tully fossils persist, the associated fauna representing the Hamilton congeries of the region. In western New York a band of pyrites 1 to 4 inches in thickness represents the 20 inches of Tully limestone in New York. The very interesting fauna representing the western extension of the Tully horizon has been described by J. M. Clarke and T. B. Loomis. One of these authors states:

"The Tully pyrite contains a fauna so diminutive that it escapes ordinary observation; so simple that it seems like a group of young forms; and

[1] Natural History of the European Seas, 1859, p. 246.

[2] Fifteenth Ann. Rep. State Geol., New York, 1897, pp. 183-185.

so unlike the usual species of the limestone that without definite knowledge of its horizon it would be difficult to locate its stratigraphic position.

"It is a deposition synchronous with and in continuation of the Tully limestone in a region where that formation is no longer represented by limestone sedimentation, where indeed bathymetric conditions did not permit the deposition of such a sediment."[1]

In Maryland we have in the Onondaga shale member of the Romney formation a fauna which, like the Tully pyrite band of western New York, shows peculiarities which are unknown in the pure limestone fauna of the Onondaga limestone of New York. In it we find corals almost entirely wanting while fragile-shelled brachiopods quite unknown in the Onondaga limestone of New York are conspicuous. The extraordinary long fragile spines on the new *Chonetes rugosa* in this fauna and the even more tenuous spines of remarkable length on *Chonetes buttsi* of the Pennsylvania Onondaga speak decisively of bathymetric conditions which differed materially from those under which the Onondaga limestone accumulated. But we have as faunal evidence of the identity of the Maryland fauna with the New York Onondaga the presence of such well-known pre-Marcellus species as *Anoplea nucleata, Anoplotheca camilla, Anoplotheca acutiplicata,*[2] *Dalmanella lenticularis, Phacops cristata,* and *Bollia obesa.*

In order to comprehend the stratigraphic relations of the beds holding the Onondaga fauna, it will be helpful to refer briefly to the general conditions controlling sedimentation during the Devonian in what has been called the Alleghany province. The greater part of the Alleghany province was occupied during the Devonian by a broad arm of the sea known as the Appalachian Gulf. Along the eastern border of this sea was deposited the 5000 to 10,000 feet of Devonian sediments found in the Alleghany region. The chief source of this clastic material has been shown to be a land area known as the highlands of Appalachia which lay immediately southeast of the Alleghany region. This old land area

[1] Bull. New York State Mus., No. lxix, 1903, pp. 892-893.

[2] Prof. C. S. Prosser informs me that he has found *A. acutiplicata* in a Hamilton fauna at one point on Evitts Creek, Md. No other post-Onondaga occurrence of this species is known so far as the writer is informed.

furnished to the interior Devonian sea of the Appalachian region, between the beginning of Middle Devonian time and the close of the Devonian, a mass of terrigenous sediments which, if restored upon a sea-level plain of Appalachia, "would constitute a mountain range closely resembling in height, extent, and mass the Sierra Nevada of California."[1] In marked contrast with this great thickness of clastic sediments which represent Devonian time in the Alleghany region we find in the Ohio valley less than 200 feet of sediments representing about the same time interval which is represented by the 5000 feet of Devonian sediments in the Middle Alleghany region. Although the land which furnished most of the Devonian sediments of the Middle Alleghany region has long since disappeared, we know from the great mass of sandy and argillaceous sediments which it furnished that it was composed chiefly of noncalcareous rocks. In the Ohio and Mississippi valleys we know both from the character of the sediments and the remnants of Devonian lands yet uncovered in the region that the source of sediments during Middle Devonian time in the western part of the Appalachian Gulf was chiefly limestone lands representing Silurian and Ordovician terranes. Such limestone lands formed the western shore of the Onondaga sea in Ohio, Indiana, and Kentucky. It is doubtless due chiefly to the different constituents of the rocks which furnished sediments to the Middle Devonian sea on the eastern and western sides of the Appalachian Gulf that we find limestones representing the sediments of Onondaga and Hamilton time in the central states, and shales and sandstones their chief constituents in the Maryland region.

These contrasts in the type of Middle Devonian sediments on opposite sides of the Appalachian Gulf are comparable with those which we find at present around the coasts of the Gulf of Mexico. Off the mouth of the Mississippi River immense deposits of argillaceous mud are forming which may eventually become a shale formation not unlike the Romney of Maryland. A few hundred miles to the eastward in the Florida-Bahama region we find vast areas of chalky mud from which we may expect a lime-

[1] Md. Geol. Survey, Vol. IV, Pt. I, p. 62.

stone not greatly unlike the Onondaga to be developed in the future. Dr. Vaughan's work on the Florida coast has shown that the bottom deposits now forming inside the Florida Keys vary from quartz sand to nearly pure calcareous ooze. He writes:

"Silica is abundant in the form of sand in the northern portion of Biscayne Bay, it becomes rarer toward the southwest, and is present in small quantities as far as Big Pine Key. Toward the southwest, as the silicious material becomes rarer, calcium carbonate becomes progressively more abundant, occurring as a flocculent sediment or ooze over practically the entire region from the lower portion of Biscayne Bay to the Gulf end of Florida Bay." [1]

The recent important discovery by Dr. G. H. Drew [2] of the part played by marine bacteria in producing chemical conditions favorable to the precipitation of calcium carbonate gives a clue to the mode of origin of these incipient limestones of the Florida Keys. We may infer that where limestones were deposited during Onondaga time as in the central states the deposition may have been due to the presence of such bacteria combined with conditions affording a limited supply of clastic sediments. The environment considered especially favorable for these denitrifying bacteria at present includes a tropical or subtropical climate with "drainage into the sea of a well-wooded country composed of calcareous rock, and the soluble organic calcium salts would be precipitated as calcium carbonate by the action of the bacteria." [3]

[1] Vaughan, Thomas Wayland: A contribution to the geological history of the Floridian plateau; Carnegie Institution of Washington, Publication 133, 1910, p. 119.

[2] Year Book, Carnegie Inst., No. 10, 1911, p. 125.

[3] Drew, G. H., *ibid.*, p. 139.

SYSTEMATIC PALEONTOLOGY
OF
THE MIDDLE DEVONIAN DEPOSITS OF MARYLAND

BY

CHARLES S. PROSSER, EDWARD M. KINDLE,
E. O. ULRICH and R. S. BASSLER

SYSTEMATIC PALEONTOLOGY

MIDDLE DEVONIAN

COELENTERATA .... CHARLES S. PROSSER.

VERMES .... E. M. KINDLE.

MOLLUSCOIDEA.

BRYOZOA .... E. O. ULRICH and R. S. BASSLER.

BRACHIOPODA .... CHARLES S. PROSSER and E. M. KINDLE.

MOLLUSCA.

PELECYPODA .... CHARLES S. PROSSER and E. M. KINDLE.

GASTROPODA .... CHARLES S. PROSSER and E. M. KINDLE.

CEPHALOPODA .... CHARLES S. PROSSER and E. M. KINDLE.

ARTHROPODA.

TRILOBITA .... CHARLES S. PROSSER and E. M. KINDLE.

OSTRACODA .... E. M. KINDLE.

COELENTERATA[1]

CLASS ANTHOZOA

Order TETRACORALLA

Family ZAPHRENTIDAE

Genus STEREOLASMA Simpson

STEREOLASMA RECTUM (Hall)

Plate VII, Fig. 1

Strombodes (?) rectus Hall, 1843, Geol. N. Y., pt. iv, p. 209, fig. 5.
Streptelasma rectum Hall, 1876 (in part), Ill. Devonian fossils, pl. xix, fig. 9.
Streptelasma rectum Grabau, 1899, Bull. Buffalo Soc. Nat. Sciences, vol. vi, p. 122, fig. 2.
Stereolasma rectum Simpson, 1900, Bull. N. Y. State Mus., No. 39, p. 205.
Stereolasma rectum Clarke, 1903, N. Y. State Mus. Bull. 65, p. 55.
Streptelasma (Stereolasma) rectum Grabau and Shimer, 1906, N. Am. Index Fossils, vol. i, p. 56, figs. 78, 79.

Description.—Corallum rather small, conical outline, rapidly tapering toward the base; septa twisted near the center of the calyx forming a central solid axis or pseudocolumella which projects prominently from the bottom of the calyx; dissepiments and tabulae frequent; fossula well marked; height, 3 or 4 cm., diameter of calyx, 1.5 to 2 cm.

[1] The author desires gratefully to acknowledge the assistance given by Dr. John M. Clarke and Professors Amadeus W. Grabau and Charles Schuchert whom he has frequently consulted regarding the identification of imperfect and doubtful specimens and those which are described as new species. He also acknowledges the great assistance derived from the classic volumes of New York Devonian Palæontology in the descriptions of the species. Many of those for the Brachiopoda, Pelecypoda, Gastropoda and Cephalopoda are modified from the well known and standard ones of that Nestor of American Paleontology—Prof. James Hall—as published in volumes IV and V, parts I and II, of the Palæontology of New York; those for the Crustacea are based in a similar manner upon the equally scholarly work by Hall and Clarke in volume VII, while the characterization of the Corals in volume VI of the Bulletin of the Buffalo Society of Natural Sciences by Prof. Grabau has been drawn upon for the description of the Maryland specimens.

C. S. P.

Comparatively few rather small specimens of this species have been found in Maryland. The longest one in the State Collection, from which the tip is gone, is 23 mm., with a greatest width, as crushed, of 14 mm. The specimens have conspicuous costal ridges on the exterior, as in figures of this species; the longer septa reach the center where they are slightly twisted, and a pseudocolumella is also shown at the center.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Ernstville; east bank of Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; New York State Museum [1]; American Museum of Natural History.[2]

Genus AMPLEXUS Sowerby

Cf. AMPLEXUS HAMILTONIAE Hall

Plate VII, Fig. 2

Amplexus hamiltoniae **Hall, 1876, Ill. Devonian fossils, pl. xix.**
Amplexus hamiltoniae **Grabau, 1899, Bull. Buffalo Soc. Nat. Sciences, vol. vi, p. 124, fig. 5.**
Amplexus hamiltoniae **Grabau and Shimer, 1906, N. Am. Index Fossils, vol. i, p. 59, fig. 86.**

Description.—*Amplexus hamiltoniae* has been described as follows: " [Corallum] elongated cylindrical, gently tapering form, often abruptly bent at the base; strongly wrinkled epitheca; comparatively slight development of septa; well developed tabulae, bent down near the thin wall." Grabau, 1899.

The single specimen in the Maryland collection is elongated, tapering toward the base near which it is abruptly contracted; bent near the middle and the epitheca is strongly wrinkled.

[1] This and the following species credited to this Museum are listed in the " Catalogue of type specimens of Paleozoic fossils in New York State Museum "; New York State Museum, Bulletin 65, 1903.

[2] This and the following species credited to this Museum are listed in the " Catalogue of the types and figured specimens in the Palæontological Collection of the Geological Department, American Museum of Natural History "; Bulletin of the American Museum of Natural History, vol. xi, 1900, pp. 189-357.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collection.—Maryland Geological Survey.

Family CYATHOPHYLLIDAE

Genus HELIOPHYLLUM Hall

HELIOPHYLLUM sp.

Plate VII, Fig. 3

This is a small, broken specimen, the apex of which is wanting; the corallum is simple and apparently rather turbinate in form; thin and wrinkled epitheca; conspicuous septa which apparently do not reach the center; and the center of about the upper half of the individual is apparently an open cup which forms the calyx.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Ernstville.

Collection.—Maryland Geological Survey.

Family CYSTIPHYLLIDAE

Genus CYSTIPHYLLUM Lonsdale

CYSTIPHYLLUM AMERICANUM Milne-Edwards and Haime (?)

Plate VII, Figs. 4, 5

Cystiphyllum cylindricum **Hall, 1843, Geol. N. Y., pt. iv, p. 209, figs. 1, 2. (Not Lonsdale.)**

Cystiphyllum americanum **Milne-Edwards and Haime, 1851, Mon. Pol. Foss. d. Terr. Pal., p. 464, pl. xiii, figs. 4, 4a.**

Cystiphyllum americanum **Rominger, 1876, Geol. Surv. Mich., vol. iii, pt. ii, p. 138, pl. l, figs. upper tier of plate and right hand one of lower tier.**

Cystiphyllum americanum **Grabau, 1899, Bull. Buffalo Soc. Nat. Sciences, vol. vi, pp. 126, 127, fig. 10 on p. 127.**

Cystiphyllum vesiculosum **Grabau and Shimer, 1906, N. Am. Index Fossils, vol. i, p. 63, fig. 93.**

Description.—Corallum simple, elongated, cylindrical to turbinate, straight or slightly curved form; epitheca thin, but strongly wrinkled concentrically; calyx moderately deep with faint indications of septal ridges on its sides; irregular vesicular tissue, dense near the wall, coarser near the center.

In general this species shows great variations in mode of growth and in the relative size of the vesicles. Some of the cylindrical specimens are more than a foot in length while the turbinate ones are much shorter.

The few Maryland specimens are turbinate in form, tapering rapidly toward the base; the largest one with a length of over 40 mm. (the base is wanting) and a diameter of about 37 mm.; the exterior is strongly wrinkled concentrically. A horizontal section shows a thick mass of vesicular tissue which is denser near the wall, faint septa on its inner surface and a calyx of considerable diameter, which on the section plane has a diameter of 16 mm. where the entire diameter of the coral is 35 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collection.—Maryland Geological Survey.

VERMES

CLASS ANNELIDA

Order CHAETOPODA

Suborder ERRANTIA

Genus POLYGNATHUS Hinde

POLYGNATHUS sp.

Plate VII, Fig. 6

***Polygnathus* sp. undet., Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 67, pl. ii, fig. 5.**

Description.—Base slightly arched; teeth nearly uniform in size, ten or more in number, conical and acutely pointed. The base has a length of about 3 mm. and the teeth a height of ½ mm.

The only specimen which has been observed is incomplete, a portion of the base and the basal portion of some of the teeth having been broken away.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Tonoloway, in black blocky shale.

Collection.—U. S. National Museum.

[E. M. Kindle.]

MOLLUSCOIDEA

CLASS BRYOZOA

Order CTENOSTOMATA

Family RHOPALONARIIDAE

Genus RHOPALONARIA Ulrich

RHOPALONARIA TENUIS Ulrich and Bassler

Plate VII, Figs. 7-9

Rhopalonaria tenuis **Ulrich and Bassler, 1904, Smith. Misc. Collections, vol. xlv, No. 1452, p. 270, pl. lxvi, figs. 7-9.**

Description.—Zoarium adnate, excavating the surface of the host so as to become usually about half imbedded in it and consisting of attenuate fusiform cells averaging about 3 in 2.0 mm.

The geographical range of this species which has hitherto been recorded from the Hamilton of Michigan, Ontario and New York is now extended to Maryland by the discovery of a specimen in the Romney shales at Wolfe Mill. This specimen consists of rather poorly preserved excavated molds in the surface of a shell but the excavations are distinct enough for the recognition of the species.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collection.—Maryland Geological Survey; U. S. National Museum.

Order TREPOSTOMATA

Family MONTICULIPORIDAE

Genus MONTICULIPORA d'Orbigny

MONTICULIPORA (?) MARYLANDENSIS n. sp.

Plate VII, Figs. 10-12

Description.—Zoarium a lamellate expansion varying from 2 to 6 or more millimeters in thickness and made up of a number of superimposed layers. Zooecia angular, polygonal, thin-walled, about 5 in 2 mm. Acan-

thopores although small and rather few, quite a feature of tangential sections. Mesopores wanting, the small angular cells seen in tangential sections being young zooecia. The principal feature of vertical sections is the presence of more or less curved diaphragms, three or four occurring in the distance of a tube diameter in the peripheral region of the zooecia while in the axial region these structures are much less frequent.

This species agrees in method of growth and tabulation with *Monticulipora* (?) *winchelli* Ulrich, another Hamilton form, but the two may readily be distinguished by the different size of their respective zooecia, *M.* (?) *marylandensis* having about 5 in 2 mm., while 7 to 8 zooecia may be counted in the same space in *M.* (?) *winchelli*.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collection.—Maryland Geological Survey.

CLASS BRACHIOPODA[1]

Order ATREMATA

Superfamily LINGULACEA

Family LINGULELLIDAE

Genus LINGULELLA Salter

LINGULELLA (?) PALIFORMIS Hall

Plate VIII, Figs. 1-4

Lingula paliformis Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 76, fig. 1.
Lingula palaeformis Hall, 1867, Pal. N. Y., vol. iv, p. 8, pl. i, fig. 7.
Lingulella (?) *palaeformis* Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pp. 59, 64, pl. ii, figs. 6-8.
Lingulella (?) *paliformis* Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, p. 258.
Lingulella (?) *paliformis* Clarke, 1903, N. Y. State Mus. Bull. 65, p. 250.

Description.—"Shell broadly subovate; sides sloping in a nearly straight line from the beak to half the length of the shell, convex at the

[1] Contributed by Charles S. Prosser with additions of Onondaga species by E. M. Kindle as indicated.

umbo and depressed below, the length a little greater than the greatest width, rapidly expanding for about two-thirds the length of the shell, below which it is abruptly rounded; shell thick; surface marked by strong concentric lamellose striae, and, in the exfoliated surface, by fine radiating striae." Hall, 1867.

Several specimens were found in the bluish shales of Evitts Creek below Wolfe Mill which agree fairly well with the description of the above species. Their outline is similar, except that the anterior part of the shell is not as broad; but the concentric lamellose striae and fine radiating ones are well shown. They were compared with the specimen figured as *L.* (?) *paliformis* Hall (Pal. N. Y., vol. viii, pt. i, pl. ii, fig. 7) with which they closely agree in form, and the strong concentric lamellose striae conspicuous on the type specimens are well shown on the Maryland ones.

Length, 7½-12 mm.; width, 4½-11 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Family LINGULIDAE

Genus LINGULA Bruguière

LINGULA DELIA Hall (?)

Plate VIII, Fig. 5

Lingula delia Hall, 1863, Sixteenth Rep. N. Y. State Cab. Nat. Hist., p. 22.
Lingula delia Hall, 1867, Pal. N. Y., vol. iv, p. 12, pl. ii, fig. 9.
Lingula delia Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, p. 15, pl. i, fig. 29.
Lingula delia Clarke, 1903, N. Y. State Mus. Bull. 65, p. 247.

Description.—" Shell elliptical, twice as long as wide; sides gently curving; front very regularly rounded; cardinal slopes abrupt, nearly

straight; substance of shell very thin. In the ventral valve[1] a strongly impressed linear indentation marks the center of the shell from the vicinity of the beak more than half way to the front. Surface marked by extremely fine concentric striae, and, below the center of the shell, by numerous undulations, which are stronger on the middle and become obsolete on the sides." Hall, 1867.

Two specimens apparently of this species were found in the bluish somewhat arenaceous shales on the bank of Evitts Creek below Wolfe Mill. One specimen has the characteristic elliptical shape of this species, the fine concentric striae and the rather strong undulations on the middle portion of the anterior half of the valve. The other specimen is broken, but is apparently of elliptical shape and the central part of the valve for half its length is marked by a conspicuous linear indentation.

Length, 17 mm.; width, 9 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collection.—Maryland Geological Survey.

LINGULA LIGEA Hall (?)

Plate VIII, Fig. 6

Lingula ligea Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 76.
Lingula ligea Hall, 1867, Pal. N. Y., vol. iv, p. 7, pl. i, fig. 2.
Lingula ligea Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 249.
Lingula ligea Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 197, fig. 229d.

Description.—" Shell narrow elliptical; length equal to twice the width; sides regularly curving; extremities subequal; margins of the valves thickened. Surface marked by fine concentric striae, and by a few obscure or obsolete radiating striae. The typical forms are about half an inch in length and one-quarter of an inch in width." Hall, 1867.

[1] In this work the well known terms ventral valve and dorsal valve are used. Dr. J. M. Clarke and some other paleontologists in their later publications call the ventral the pedicle valve and the dorsal the brachial valve.

One specimen from the shales on the bank of Evitts Creek below Wolfe Mill agrees fairly well with the figures and description of this species, except that the beak is not so pointed; another one showing the interior of a valve from the B. & O. R. R. cut at 21st Bridge agrees fairly well with this species.

Length, 12 mm.; width, 7 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; B. & O. R. R. cut at 21st Bridge.

Collection.—Maryland Geological Survey.

LINGULA cf. NUDA Hall

Plate VIII, Figs. 7, 8

Lingula nuda Hall, 1863, Sixteenth Rep. N. Y. State Cab. Nat. Hist., p. 22.
Lingula nuda Hall, 1867, Pal. N. Y., vol. iv, p. 10, pl. ii, figs. 4-6.
Lingula nuda Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 251.
Lingula nuda Clarke, 1903, N. Y. State Mus. Bull. 65, p. 247.

Description.—" Shell subelliptical; length nearly twice as great as the width; sides subparallel, very slightly curving, the greatest width near the center; front truncated. Cardinal slopes rounded, the ventral valve a little more pointed and more convex than the dorsal valve. Dorsal valve nearly flat. Ventral valve, in exfoliated specimens, marked by a depressed line down the center. Surface marked by fine concentric striae, which, on the margins, are crowded and wrinkled." Hall, 1867.

There is apparently a slightly raised median line, while the concentric striae are faintly shown near the margins of the shell. The specimen from Williams Road 3½ miles southeast of Cumberland was sent to Dr. J. M. Clarke who wrote as follows regarding it: "The *Lingula* seems to me, notwithstanding its distortion by shearing, a specimen of *L. nuda* or *L. densa*. It agrees well with either in outline; better with the former in size." Prof. Schuchert made the following note regarding the same specimen: "It looks to me more like a young compressed *L. punctata;* but I would not be sure of this." In the writer's opinion the specimens approach *L. nuda* more nearly than any other species.[1]

[1] The latter is shown on pl. viii, figs. 9, 10.

Length, 7, 11 mm.; width, 5½, 7 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road 3½ miles southeast of Cumberland. HAMILTON MEMBER. Oldtown Road near Cumberland; B. & O. R. R. cut at 21st Bridge; Williams Road ¼ mile east of Queen City Hotel, Cumberland; Williams Road, 3½ miles southeast of Cumberland; on Oldtown Road east of Maryland Ave., Cumberland.

Collection.—Maryland Geological Survey.

LINGULA cf. COMPTA Hall and Clarke

Plate VIII, Fig. 11

Lingula compta **Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, p. 171, pl. i, fig. 16.**
Lingula compta **Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 246.**
Lingula compta **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 246.**

Description.—" Shell very narrow, with lateral margins nearly parallel for most of their length, the anterior margin transverse and the posterior less abruptly rounded. Shell-substance thin. Surface marked by fine concentric striae. A narrow median furrow extends from just behind the center of the brachial (?) valve nearly to the anterior margin. Length of this valve, 9 mm., greatest width, 4.5 mm." Hall and Clarke, 1892.

This specimen is larger than the one figured by Hall and Clarke and its width in proportion to the length is somewhat greater.

Length, 16 mm.; width, 9 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank of Evitts Creek below Wolfe Mill.

Collection.—Maryland Geological Survey.

LINGULA CLARKI n. sp.

Plate VIII, Figs. 12, 13

Description.—Shell narrow, width about one-half the length, central portion of lateral margins parallel but tapering at each end toward the apex. Shell strongly convex along the median line from the beak well

toward the front and sloping rather abruptly toward the lateral margins. Surface marked by fine concentric striae and some coarser lines of growth.

This species somewhat resembles *Lingula compta* Hall and Clarke, but that species is larger, neither so convex along the median line nor so pointed at the extremities; also *L. ligea* Hall, but that species is larger, wider in proportion to the length and not strongly convex along the median line. This species apparently is readily distinguished from others by its narrowness and strong median convexity.

Length, 5½-8 mm.; width, 2½-4 mm.

Named in honor of Dr. William B. Clark, State Geologist of Maryland.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge.

Collection.—Maryland Geological Survey.

Superfamily DISCINACEA

Family DISCINIDAE

Genus ORBICULOIDEA d'Orbigny

ORBICULOIDEA LODIENSIS VAR. MEDIA (Hall)

Plate VIII, Figs. 14-17

Orbicula lodensis Vanuxem, 1842, Geol. N. Y., pt. iii, p. 168, fig. 1.
Orbicula lodensis Hall, 1843, Geol. N. Y., pt. iv, p. 223, fig. 1.
Discina media Hall, 1863, Sixteenth Rep. N. Y. State Cab. Nat. Hist., p. 27.
Discina lodensis Hall, 1867, Pal. N. Y., vol. iv, p. 22, pl. i, fig. 14; pl. ii, fig. 35.
Discina media Hall, 1867, Pal. N. Y., vol. iv, p. 20, pl. ii, figs. 25-29.
Discina media Walcott, 1884, Mon. U. S. Geol. Surv., vol. viii, p. 113.
Orbiculoidea lodensis Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pl. iv F, fig. 21.
Orbiculoidea media Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pl. iv E, figs. 15-17.
Orbiculoidea lodiensis media Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 279.
Orbiculoidea media Clarke, 1903, N. Y. State Mus., Bull. 65, p. 268.

Description.—" Shell broadly elliptical or subcircular, variable in form. Dorsal valve very depressed-convex; apex excentric, pointed, and inclined towards the posterior border. Ventral valve flat, or a little convex just

anterior to the foramen; foramen narrow, directly in the longitudinal axis of the shell, or often a little oblique. Surface finely and evenly striated by fine regular [concentric] elevated striae, distant from each other more than twice their width. The apex of the dorsal valve is about one-third, and sometimes less than one-third the length of the shell from the posterior margin. Perforation of the ventral valve narrowly oval or sublinear, about one-third the length of the shell from the posterior margin, and extending towards the edge of the shell." Hall, 1867.

Hall noted the close relationship of *Discina media* H. to *D. lodiensis* (Van.) suggesting that perhaps it was "only a well-marked variety of that species" (Pal. N. Y., vol. iv, p. 21) in which Walcott concurred (Mon. U. S. Geol. Surv., vol. viii, p. 113) and it is now given by Schuchert as *Orbiculoidea lodiensis media* (Hall) (Bull. U. S. Geol. Surv., No. 87, p. 279). Dr. J. M. Clarke considers *Orbiculoidea media* and *O. lodiensis* as probably the same species, the difference being due to different conditions of preservation. Some of the Maryland specimens were compared with the types in the New York State Museum and it was found that the concentric striae were very similar to those on the specimen represented by fig. 25, pl. 2, vol. iv, Pal. N. Y.; but the Maryland specimens are of considerably smaller size. They may also be compared with specimens of *Orbiculoidea lodiensis* (Van.) from the Genesee shale. The variety *media* is apparently distinguished from the species *O. lodiensis* mainly by its generally larger size, coarser concentric striae which are also farther apart, and absence of the faint radiating folds.

Kindle states that this is an abundant fossil of the Onondaga fauna at most localities from northeastern Pennsylvania to northern Virginia.

Length, 6½-7 mm.; width, 5½-6 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Twenty-first Bridge; Williams Road, three and one half miles east of Cumberland. HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; Ernstville.

Collections.—Maryland Geological Survey; American Museum of Natural History; New York State Museum.

Superfamily CRANIACEA

Family CRANIIDAE

Genus CRANIELLA Oehlert

CRANIELLA HAMILTONIAE Hall

Plate IX, Figs. 1-7

Crania hamiltoniae Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 77, figs. 4, 5 on p. 76.
Crania hamiltoniae Hall, 1867, Pal. N. Y., vol. iv, p. 27, pl. iii, figs. 17-23.
Craniella hamiltoniae Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pp. 148, 153, pl. iv I, figs. 3-16.
Craniella hamiltoniae Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 193.
Craniella hamiltoniae Clarke, 1903, N. Y. State Mus., Bull. 65, p. 219.
Craniella hamiltoniae Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 208, fig. 244.

Description.—Shell broadly oval or subcircular. Dorsal valve subconical; apex subcentral or eccentric, pointed in well preserved specimens, often worn or decorticated; exterior surface marked by concentric lamellose striae. Ventral or lower valve marked by four strong impressions of the adductor muscles, which are variable in form; vascular impressions strongly digitate.

Three imperfectly preserved specimens of the dorsal or upper valve were found in the bluish shales on the bank of Evitts Creek below Wolfe Mill; which locality, of those yet studied in Maryland, has furnished the largest number of specimens of the Inarticulate Brachiopoda. The shell is partly preserved in these specimens and it is shown to be highly punctate. The other characters are imperfectly shown; but the usual muscular scars and apparently the peculiar sigmoid vascular sinus of the upper or dorsal valve are present. It is to be remembered that Hall identified this species from "the Hamilton group in Maryland and Virginia" (Pal. N. Y., vol. iv, p. 28). The specimens were submitted to Prof. Charles Schuchert who agreed in this identification and called attention to the "sigmoid vascular sinus, the generic character of *Craniella*."

Length, about 18 mm.; width, 19 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. 1¾ miles south of Berkeley Springs, West Virginia. HAMILTON MEMBER. East bank of Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Genus PHOLIDOPS Hall

PHOLIDOPS HAMILTONIAE Hall

Plate IX, Fig. 8

Pholidops hamiltoniae **Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 92.**
Pholidops hamiltoniae **Hall, 1867, Pal. N. Y., vol. iv, p. 32, pl. iii, figs. 6-9.**
Pholidops hamiltoniae **Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, p. 157, pl. iv I, figs. 31-34.**
Pholidops hamiltoniae **Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 306.**
Pholidops hamiltoniae **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 283.**
Pholidops hamiltoniae **Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 209, fig. 245.**

Description.—Shell regularly and uniformly ovate, broader near the posterior end; apex eccentric, little elevated, and slightly inclining to the posterior side. Substance of the shell thin, and flattened toward the margins. Surface marked by fine closely arranged lamellose striae and when magnified, shows indications of minute interrupted radiating striae. Interior smooth, except an ovate, somewhat auriculate, and sometimes slightly bilobed prominence beneath the apex, which marks the muscular impression. The casts of the interior show a comparatively large muscular impression, which is shield-shaped or subovate and somewhat auriculate, or with a deeper impression on each side above the middle.

The Maryland specimens are imperfectly preserved, and but few characters are shown. They are minute, and one valve is somewhat convex with a rather deep muscular impression at the apex with the surface of the shell marked by lamellose concentric striae. One specimen apparently shows fine radiating striae; the outline of the shell, however, does not appear so ovate as that of *P. hamiltoniae.* The specimen with strong concentric lines is apparently nearly circular in outline and suggested a

comparison with *Orbiculoidea minuta* (Hall) and this opinion was communicated to Prof. Schuchert. He wrote, however, after examining the specimen that it is a *Pholidops* and that the shell of "*Orbiculoidea minuta* is more phosphatic and does not show the strong concentric growth lines as in this specimen." The other specimens he said "are hardly good enough to make out and yet what one can see agrees with *Pholidops hamiltoniae*. The Pholidops have great distribution and it is safe to say that you have the *P. hamiltoniae*."

Length, 1 mm. +; width, about 1 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road 3½ miles southeast of Cumberland and 25 yards west of Oriskany contact.

Collection.—Maryland Geological Survey.

PHOLIDOPS CF. AREOLATA (Hall)

Plate IX, Figs. 9, 10

cf. ***Pholidops areolata*** **Hall, 1863, 16th Rept. N. Y. State Cab. Nat. Hist., p. 31.**
cf. ***Pholidops areolata*** **Hall, 1867, Nat. Hist. N. Y., Pal., vol. iv, p. 31, pl. iii, figs. 4, 5.**
Pholidops **cf. *areolata* Kindle, 1912, Bull. U. S. Geol. Survey, No. 508, p. 70, pl. ii, figs. 7, 8.**

Description.—"Shell broadly subovate or scarcely circular, wider on the posterior third, broadly rounded behind and more narrowly rounded in front. The cast of one valve (the dorsal valve?) shows a deep ovate or subcordiform muscular scar, which is nearly surrounded by an elevated areola, and partially divided by a median ridge from above. The opposite (ventral?) valve has a larger muscular scar, which is auriculated above, with the surrounding areola divided at the lower or anterior margin. Surface somewhat abruptly flattened on the posterior side, and more gently sloping on the front of the valve." Hall, 1867.

"The shell is subovate, the width of the posterior portion being slightly greater than that of the anterior. Surface marked by strongly lamellose concentric striae. The mold of the interior of the ventral valve shows a

strongly impressed muscular scar, deepest anteriorly, somewhat resembling the impression of a bovine hoof." Kindle, 1912.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles east of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Order PROTREMATA

Superfamily STROPHOMENACEA

Family STROPHOMENIDAE

Genus STROPHEODONTA Hall

STROPHEODONTA (LEPTOSTROPHIA) PERPLANA (Conrad)

Plate IX, Figs. 11-17

Strophomena perplana Conrad, 1842, Jour. Acad. Nat. Sci. Phila., vol. viii, p. 257, pl. xiv, fig. 11.
Strophomena (*Strophodonta*) *fragilis* Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 111.
Strophomena perplana Rogers, 1858, Geol. Penna., vol. ii, pt. ii, p. 827, fig. 665.
Strophodonta fragilis Hall, 1858, Geol. Iowa, vol. i, pt. ii, p. 496, pl. iii, fig. 6.
Strophodonta perplana Hall, 1867, Pal. N. Y., vol. iv, pp. 92, 98, pl. xi, fig. 22; pl. xii, figs. 13-15; pl. xvii, figs. 1*a*-1*o*.
Strophodonta perplana Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Stropheodonta (*Leptostrophia*) *perplana* Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, p. 288, pl. xv, figs. 2-13.
Stropheodonta perplana Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 425.
Leptostrophia perplana Clarke, 1903, N. Y. State Mus., Bull. 65, p. 243.
Stropheodonta (*Leptostrophia*) *perplana* Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 217, fig. 264.

Description.—Shell small to medium size, very thin, semielliptical; slightly concavo-convex, and frequently nearly flat; hinge-line equaling or often a little greater than the width of the shell below, cardinal extremities usually somewhat salient; margins of the shell often a little contracted just below the cardinal extremities, making the width less than below; but the sides are frequently nearly straight for half their length, with the front broadly rounded. Ventral valve slightly convex, the greatest

convexity above the middle of its length; cardinal area narrow, vertically striated and crenulated on the inner margin; apex scarcely higher than the hinge-line. Dorsal valve slightly concave and frequently nearly flat. Surface marked by fine subequal striae, those of the ventral valve the finer, sharp and sometimes gently undulating, increasing both by bifurcation and intercalation, and crossed by fine, close, even concentric striae; near the apex are frequently a few obscure concentric wrinkles which occur occasionally upon the body of the shell. The interior of the ventral valve marked by large flabelliform diductor muscular impressions, extending more than half the length of the shell, with small adductors between and near the beak; the muscular impressions of the dorsal valve are not strongly marked and are separated above by a median ridge which divides in the bifurcating cardinal process and from each side a rounded ridge curves forward and outward; the interior strongly pustulose.

Some of the Maryland specimens are quite well preserved and clearly show the fine several times bifurcating striae, as well as the flat form of the shell, concentric wrinkles and slightly mucronate cardinal extremities. Internal impressions of the ventral valve are not uncommon which show well the flabelliform diductor muscular impressions. A few specimens have a median ridge or cicatrix extending from the vicinity of the beak or central part of the valve to its front. On the median part of the shell the radiating striae converge toward this ridge and the concentric striae in crossing it curve toward the umbo. The ridge was probably produced by an injury to the shell and the type specimen represented by fig. 1*c* on pl. 17, vol. iv, Pal. N. Y., has a similar ridge along the middle part of the opposite valve. The species is readily distinguished by its outline, nearly flat form, fine, distinct, and nearly equal bifurcating striae, while the muscular markings and pustulose surface of the interior are characteristic.

Length, 25-33 mm.; with, 30-50 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road, 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill; Williams Road ¾ mile east of Queen City Hotel, Cumberland;

Williams Road, ¼ mile east of Queen City Hotel, Cumberland; in Jennings Run, ½ mile west of Corriganville; Town Creek Road at George Diefenbaugh's; B. & O. R. R. cut at 21st Bridge; on Hancock-Harrisonville Road about 2 miles north of Hancock; McCoys Ferry; along Flintstone Creek in Gilpin; on National Road in Gilpin; west of iron bridge over Town Creek northeast of Oldtown; on road east of Pine Hill about 4 miles north of Oldtown; B. & O. R. R. cut at Hancock Station, W. Va.; on road about half way between Romney and Hanging Rock, W. Va.

Collections.—Maryland Geological Survey; American Museum of Natural History.

STROPHEODONTA DEMISSA (Conrad)

Plate X, Fig. 1

Strophomena demissa Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 258, pl. xiv, fig. 14.

Strophomena (Strophodonta) demissa Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 137, fig. 1.

Strophomena demissa Rogers, 1858, Geol. Penna., vol. ii, p. 827, fig. 666.

Strophodonta demissa Hall, 1858, Geol. Surv. Iowa, vol. i, pt. ii, p. 495, pl. iii, fig. 5.

Strophodonta demissa Hall, 1867, Pal. N. Y., vol. iv, p. 81, pl. xi, figs. 14-17; pl. xii, figs. 1-5; pl. xvii, figs. 2a-2s.

Strophodonta demissa Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.

Stropheodonta demissa Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pl. xiv, figs. 7-12.

Stropheodonta demissa Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 421.

Stropheodonta demissa Clarke, 1903, N. Y. State Mus., Bull. 65, p. 333.

Stropheodonta demissa Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 217, fig. 263.

Description.—Shell medium size; semi-elliptical, generally wider than long although the proportions are often nearly equal; hinge-line variable in length in proportion to the width of the shell below; lateral margins abruptly contracted beneath the cardinal extremities, which are often auriculate. Ventral valve regularly convex, greatest elevation nearly central. Umbo small and prominent with the apex slightly incurved;

surface slightly concave toward the cardinal angles and sometimes a slightly raised median ridge crosses the valve. Dorsal valve moderately concave, rarely following the convexity of the opposite valve; sometimes an undefined median depression extends from beneath the beak to the front of the shell. Surface marked by numerous striae, about nine or ten of which are much stronger and more elevated on the umbo of the ventral valve, with finer striae appearing in the middle of the intervening space and on either side of the coarser ones; the striae frequently increasing by intercalation and bifurcation, until they become very numerous and much finer at the margin; the striae of the dorsal valve similar to those of the ventral; in well preserved specimens fine concentric striae cover the surface, and there are frequently heavy concentric lines of growth. The interior of the ventral valve, and impressions of the same, show a large flabelliform diductor muscular impression, separated towards the front and distinctly lobed, with small adductors between them, separated from each other by a depression; in the dorsal valve the adductor impressions are conspicuous, divided longitudinally by a narrow ridge, and often limited in front by elevated ridges; beyond the muscular impressions the interior surface of both valves is minutely pustulose.

Specimens from Maryland are almost identical in form and markings with some of those figured by Hall from the Hamilton formation of New York, in particular see figs. 2*d* and 2*g*, pl. 17, vol. iv, Palæontology New York, which are stated to be ventral and dorsal valves of the ordinary form. This species is readily distinguished from *S. perplana* (Con.) by its thicker shells, greater convexity and much coarser striae which are slightly undulating and variable in strength so that the external appearance of the two species is quite different.

Length, 23 mm.; width, 33 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; in Jennings Run, ½ mile west of Corriganville; on Hancock-Harrisonville Road about 2 miles north of Hancock.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

STROPHEODONTA (DOUVILLINA) INAEQUISTRIATA (Conrad)

Plate X, Figs. 2-5

Strophomena inaequistriata Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 254, pl. xiv, fig. 2.

Strophomena inaequistriata Hall, 1843, Geol. N. Y., pt. iv, p. 201, fig. 4 on p. 200.

Strophomena (*Strophodonta*) *inaequistriata* Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 142.

Strophodonta inaequistriata Hall, 1867, Pal. N. Y., vol. iv, p. 93, pl. xii, figs. 6-8; p. 106, pl. xviii, figs. 2*a*-2*k*.

Stropheodonta (*Douvillina*) *inaequistriata* Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, p. 289, pl. xiv, figs. 1-6; pl. xv B, fig. 9.

Stropheodonta inaequistriata Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 422.

Douvillina inaequistriata Clarke, 1903, N. Y. State Mus., p. 231.

Stropheodonta inaequistriata Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 217, fig. 262.

Description.—Shell generally less than medium size and somewhat semioval in outline; hinge-line longer than the width of the shell below: extremities acute, sometimes auriculate. Rarely, the sides are nearly straight below the auriculate extremities, the basal curve rather straightened on each side and produced in a subnasute extension in the middle. Ventral valve usually regularly convex, often more gibbous in the middle and abruptly arched toward the hinge-line, depressed-convex on the disc, with the margin towards the front more abruptly curving; the beak is small, scarcely prominent on the hinge-line. Cardinal area is narrow-linear, extending to the extremities of the hinge-line, striated vertically, with the inner margins crenulate from one-half to two-thirds the length from the beak to the extremities; no foramen. Dorsal valve moderately to deeply concave; cardinal area scarcely more than one-half as wide as on the ventral valve. Surface of the entire shell marked by slender distant elevated striae, which are increased by interstitial additions, the interspaces occupied by much finer closely arranged striae, which are scarcely visible to the naked eye, and crossed by fine concentric striae. The muscular markings are well shown on both valves although subject to considerable variation; while just without the muscular areas the interior surface is rather strongly pustulose, and beyond this it is finely pustulose in lines corresponding to the external striae.

The single specimen from Maryland shows mainly an internal impression of the ventral valve; but on one side there is some of the shell clearly showing the stronger striae with three or four much finer ones occupying the interspaces. The specimen is considerably larger than the usual ones of this species; but it was shown to Dr. J. M. Clarke, who considered it a large specimen of the above species. The muscular area is high and sharply marked, a character which Dr. Clarke states is found in this species as well as a somewhat similar one in the Maryland specimens of *Stropheodonta (Douvillina) cayuta* Hall from the Jennings formation.

This species is characterized by its small to medium size; quite convex ventral valve; long hinge-line with acute to auriculate extremities and the surface marked by distinct distant striae between which are several much finer ones, scarcely visible to the naked eye.

Length of Maryland specimen, 30 mm.; width, 35 mm.

Length of average New York specimens, 15-21 mm.; width, 25-28 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; B. & O. R. R. cut at 21st Bridge (?).[1]

Collection.—Maryland Geological Survey.

STROPHEODONTA CONCAVA Hall

Plate X, Figs. 6, 7

Strophomena (Strophodonta) concava Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., pp. 115, 140, fig. 1.

Strophodonta concava Hall, 1867, Pal. N. Y., vol. iv, p. 96, pl. xiv, figs. 2*a*-2*d*; pl. xv, figs. 1-5; pl. xvi, figs. 1*a*-1*h*.

Stropheodonta concava Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pl. xiv, figs. 16-23.

Stropheodonta concava Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 420.

Stropheodonta concava Clarke, 1903, N. Y. State Mus., Bull. 65, p. 331.

Stropheodonta concava Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 216, fig. 261.

Description.—Shell large, concavo-convex or subhemispheric, broadly semielliptical or subcircular in outline; the hinge extremities are some-

[1] In general a (?) mark following a locality indicates that the specimen from that place is identified with a query.

times salient but often rounded. Ventral valve varying from moderately to extremely convex, gibbous in the middle, rounded upon the umbo and little elevated above the hinge-line, with beak small and scarcely incurved, while in some specimens a median ridge crosses the center of the valve; cardinal area about a line in width, gently narrowing towards the extremities, vertically striated, with the margin crenulated for more than half the distance from the center to the extremities. Dorsal valve usually almost flat or slightly concave in the upper and central portions, suddenly deflected towards the margin, in some specimens regularly concave; cardinal area very narrow and nearly linear throughout, striate and crenulate as in the ventral valve. Surface of the ventral valve is marked by sharply elevated, strongly crenulated striae, between which are sometimes one or two less elevated striae similarly crenulated, and still finer striae between the latter; in some specimens there are wider spaces of finer equal striae between the stronger ones; and in other specimens the striae are nearly all strong and sharply elevated, with few finer ones, which soon rise to the strength of the others; close undulating concentric striae cover the whole surface; the dorsal valve is marked by distant sharp elevated striae, between which there are from three to six and rarely ten finer striae, which are very finely crenulated by concentric striae; the interior of the valves is finely pustulose.

The Maryland collection contains a single imperfect specimen of the interior of a dorsal valve. A part of the strongly crenulated cardinal area is shown, a portion of the muscular impression outside of which it is strongly pustulose, and the pustules are larger in the central portion of the shell before reaching the deflected part toward the margin. The specimen appears somewhat like a large form of *S. demissa* (Conrad).

Length, 37 mm.; width, 43 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill (?); on the Hancock-Harrisonville Road about 2 miles north of Hancock.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Genus PHOLIDOSTROPHIA Hall and Clarke

PHOLIDOSTROPHIA PENNSYLVANICA Kindle

Plate X, Figs. 8, 9

Pholidostrophia pennsylvanicus **Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 74, pl. v, figs. 1, 2.**

Description.—Shell small, concavo-convex or plano-convex. Ventral valve depressed convex, greatest width at hinge-line and salient cardinal angles. Surface without radiating striae but with some indications of lamellose lines of growth. The impression of a single dorsal valve supposed to belong to this species is slightly concave and shows a very short slender septum extending 1 mm. from the hinge-line. The collection contains six or seven specimens. An average specimen has a width of 8 mm. at the hinge-line and a length of 6 mm.

This shell resembles both *P. iowensis* (Hall) and *Stropheodonta punti* Clarke in its smooth exterior. It is smaller than either of these however, and does not possess the crescent-shaped ridges which characterize the dorsal valve of *P. iowensis*. The absence of these may leave some doubt as to the propriety of referring this shell to *Pholidostrophia* but the smooth surface and the general features of the shell strongly indicate its relationship to this group of the *Stropheodontas*.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Genus LEPTAENA Dalman

LEPTAENA RHOMBOIDALIS (Wilckens)

Plate X, Figs. 10, 11

Conchites rhomboidalis **Wilckens, 1769, Nachricht von seltenen. Versteinerungen, p. 77, pl. viii, figs. 43, 44.**
Strophomena undulosa **Conrad, 1841, Fifth An. Rep. Geol. Surv. N. Y., p. 54.**
Strophomena depressa **Vanuxem, 1842, Geol. N. Y., pt. iii, p. 79, fig. 5.**
Strophomena undulatus **Vanuxem, 1842, Geol. N. Y., pt. iii, p. 139, fig. 3.**
Leptaena tenuistriata **Hall, 1847, Pal. N. Y., vol. i, p. 108, pl. xxxi A, fig. 4.**

Leptaena depressa Hall, 1852, Pal. N. Y., vol. ii, p. 62, pl. xxi, fig. 8; p. 257, pl. liii, fig. 6.

Leptaena depressa Rogers, 1858, Geol. Penna., vol. ii, pt. ii, p. 823, fig. 630.

Strophomena rugosa Hall, 1859, Pal. N. Y., p. 195, pl. xix, fig. 1.

Strophomena rhomboidalis Billings, 1861, Canadian Jour., vol. vi, p. 336, figs. 111, 112.

Strophomena rhomboidalis Hall, 1867, Pal. N. Y., vol. iv, p. 76, pl. xii, figs. 16-18; p. 414, pl. xv, figs. 15, 16.

Leptaena rhomboidalis Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, p. 279, pl. viii, figs. 17-31; pl. xv A, figs. 40-42; pl. xx, figs. 21-24.

Leptaena rhomboidalis Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 240.

Leptaena rhomboidalis Clarke, 1903, N. Y. State Mus., Bull. 65, p. 239.

Leptaena rhomboidalis Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 226, figs. 273a, b.

Description.—Shell of more than medium size, semielliptical or subquadrate varying in its proportions of length and breadth; hinge-line straight and equal to greatest width of shell; cardinal extremities mostly rectangular, sometimes rounded and sometimes salient; the valves are geniculated and the proportions of the flattened part or disc and the recurved portion are very variable. The surface of the flattened part is marked by strong concentric, undulating elevations, which are parallel with the curve of geniculation and are bent outwards and often become obsolete on the cardinal angles; these elevations are most prominent on the part parallel to the front margin; they are very variable in number, ranging from six to sixteen. The entire surface is covered by radiating, fairly coarse, uniform striae. The ventral valve is slightly convex near the umbo, but flat or even somewhat depressed between the umbo and geniculation; dorsal valve generally corresponding in its concavity with the convexity of the ventral, but differing in its depth.

The Maryland specimen consists of a single fragment of a ventral valve; but the strong concentric wrinkles and even striae leave no doubt as to the correctness of this identification. The species may be readily determined by its shape, the deep concentric wrinkling of the disc, the abrupt geniculation of both valves toward the dorsal side, and the uniform, sharply marked striae.

Length of average specimen from the Columbus limestone at Columbus, Ohio, 22 mm.; width, 32 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Ernstville.

Collections.—Maryland Geological Survey; American Museum of Natural History.

Genus **LEPTAENISCA** Beecher

LEPTAENISCA AUSTRALIS Kindle

Plate XI, Figs. 1-5

Leptaenisca australis **Kindle, 1912, Bull. U. S. Geol. Survey, No. 508, p. 78, pl. iv, figs. 8-12.**

Description.—Outline variable, as shown in figure; length generally less than width; hinge line somewhat shorter than greatest width of shell. Shell concavo-convex. Ventral valve moderately convex. Surface marked by fine radiating striae, which are clearly defined only in the anterior part of the shell, and which are crossed by very fine concentric striae and stronger lines of growth. The muscular pit of the ventral valve is bordered laterally by the dental lamellae which curve toward each other slightly near the anterior margin of the pit. These lamellae, as they extend into the shell and away from the surface of the valve, are inclined laterally or away from each other. A short, low, median septum extends across the muscular pit from the posterior nearly or quite to the anterior margin of the pit. Molds of the interior of the ventral valve indicate a strongly postulose surface, increasing regularly in coarseness from the margin of the shell to the margin of the muscular impression. The collection contains a single, somewhat imperfect, mold of the interior of a dorsal valve believed to belong to this species. The distinctly bipartite character of the posterior portion of the cardinal process is shown and, somewhat indistinctly, the quadripartite appearance of the anterior portion of the process is seen. A low thick median ridge is present in the anterior part of the mold.

All of the species of this genus previously described from America are Helderberg shells. In surface characters they are quite unlike the present species. Two of them appear from the figures to be nonstriated species, but the third, *L. concava,* has radiating striae of unequal strength, each

fifth or sixth being stronger than the intermediate ones. In this species the striae are all of about equal strength.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Tonoloway; 1¾ miles south of Berkeley Springs.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Genus SCHUCHERTELLA Girty[1]

SCHUCHERTELLA VARIABILIS n. sp.

Plate XI, Figs. 6-10

Schuchertella cf. *perversa* Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 76.

Description.—Shell semielliptical and symmetrical or with slight umbonal distortion; hinge-line straight and somewhat less than the greatest width of the shell; lateral margins curving toward the hinge-line and the front of the shell. Ventral (?) valve slightly convex from the umbo toward the center and flattened towards the front and sides of the valve. Surface marked by 50 rather sharp and close radiating striae on the smaller specimens and in the middle of many of the interspaces is a short and much smaller intercalated one; while the larger specimen has about 60 of the strongest striae which extend quite or nearly to the umbo and most of the interspaces show an intercalcated one in the center, second in strength to the primary, with a still fainter one on each side, making three grades of striae; a few of the interspaces show only one. The surface also crossed by very fine, thread-like and closely arranged concentric striae which are the most conspicuous on the interspaces.

[1] Dr. Girty, in 1904, proposed the generic name *Schuchertella* " for shells having the type of structure for which the name *Orthothetes* is at present in general use," for which he stated " there is no authority for spelling otherwise than *Orthotetes*." Dr. Girty shows that Fischer de Waldheim applied the name *Orthotetes* to a different type of structure than that for which it has been used in recent years and therefore he has transferred it to the group of shells for which it was originally used, which later had been named *Derbya* by Waagen, and proposed the new name for the group left without a generic name (Proc. U. S. Nat. Mus., vol. xxvii, 1904, p. 734).

These specimens are mainly small and the best ones were obtained in the argillaceous shales on the Williams Road about one-fourth mile east of the Queen City Hotel, while others came from a calcareous stratum at the iron bridge over Town Creek about 3½ miles northeast of Oldtown.

Part of the specimens of this species considerably resemble *Schuchertella chemungensis* (Conrad) var. *perversa* Hall, to which they were at first doubtfully referred. Further study led to greater uncertainty, and finally the specimens were sent to Dr. J. M. Clarke for his opinion regarding their specific relationship. After an examination Dr. Clarke wrote as follows: "I have studied the specimens of *Orthothetes* you have sent and compared them with the types of *O. perversus.* With regard to these fossils, so far as they occur in the Devonic, it is easy to see that they are in a certain sense ontogenetic expressions of a broad specific type, and it is often very difficult to draw lines among the specimens as they have been drawn by their describers. These specimens show both an extremely simple form of plication and a more complicated expression, such as would naturally result from later growth. *O. perversus* is such a species in external character as this larger specimen with intercalated plications, and yet the other specimens with simple plications seem only to express the more infantile condition longer continued. I hardly know what we shall do with facts of this kind. Doubtless the specimens are all of the same species and I should be disposed, personally, to cut the Gordian knot by describing it as a distinct species, and if you call it *O. variabilis* you would doubtless tell the truth in its name. My species *O. bellulus* from the Marcellus shales is very close to the larger of these forms and occasionally shows a simple equal plication of the smaller shells, *i. e.,* the shells pass through the same variations as do the Maryland, and yet I should hesitate to include them under that term, as the Marcellus species is much more sparsely plicate."

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. W. Va. Central R. R. cut at 21st Bridge. Williams Road, 3½ miles southeast of Cumberland. HAMILTON MEMBER. Williams Road, ¼ mile east of Queen City Hotel, Cumberland; Town Creek, 3½ miles northeast of

Oldtown; Williams Road, 3½ miles southeast of Cumberland; B. & O. R. R. cut at 21st Bridge.

Collection.—Maryland Geological Survey.

Family PRODUCTIDAE

Genus CHONETES Fischer de Waldheim

CHONETES MUCRONATUS Hall

Plate XI, Figs. 11-17

Strophomena mucronata **Hall, 1843, Geol. N. Y., pt. iv, p. 180, fig. 3.**
Chonetes laticosta **Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 119.**
Chonetes mucronata **Hall, 1867, Pal. N. Y., vol. iv, p. 124, pl. xx, figs. 1*a*-1*d*; pl. 21, figs. 1*a*-1*g*.**
Chonetes mucronata **Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pl. xvi, figs. 6, 7.**
Chonetes mucronatus **Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 176.**
Chonetes mucronatus **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 211.**
Chonetes mucronatus **Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 235, fig. 286.**

Description.—Shell small, semioval to semielliptical; moderately convex (often flattened in shale and gibbous in limestone and arenaceous deposits); hinge-line equalling or a little greater than the width of the shell below, the extremities sometimes salient. The ventral valve is often quite gibbous, regularly rounded in the middle, suddenly depressed towards the cardinal angles which are flattened, and the area narrow and linear. The dorsal valve is moderately concave to nearly flat, and the area is scarcely more than the thickness of the shell. Surface marked by from twelve to twenty usually coarse, rather distant, simple rounded or subangular striae, a few of which on some specimens bifurcate towards the margin. The cardinal margin marked by two or three spines on each side of the apex, which are bent abruptly downwards and directed outwards almost parallel to the hinge-line, so that the outer one frequently appears to be a continuation of the cardinal extremity. In the interior of the ventral valve is a strong median septum reaching more than half the length of the valve, while the interiors of the valves are strongly pustulose.

The Maryland specimens agree closely with those from the Hamilton formation of New York which Professor Hall first described under the name of *Chonetes laticosta* and later referred to *C. mucronatus,* the original description of which referred to specimens from the Marcellus shale. It would be very difficult to find any difference between these specimens and many of those from similar deposits of the Hamilton formation in New York. On some of the specimens the comparatively long spines nearly parallel to the hinge-line are nicely shown, which give the cardinal angles a mucronate appearance. This species is readily distinguished by its size, outline, moderate convexity, strong rounded or subangular striae, and the two or three cardinal spines which curve abruptly outward parallel to the hinge-line.

Kindle states that this is one of the most abundant species of the Onondaga fauna being found nearly everywhere in it from New York to southwest Virginia.

Length, 6 or 7 mm.; width, 8 to 10 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland. HAMILTON MEMBER. Williams Road, 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill (?); Williams Road ¼ mile east of Queen City Hotel, Cumberland; in Jennings Run, ½ mile west of Corriganville; Town Creek Road at George Diefenbaugh's; B. & O. R. R. cut at 21st Bridge; on Oldtown Road, east of Maryland Ave., Cumberland; on the Hancock-Harrisonville Road about 2 miles north of Hancock; McCoys Ferry; on National Road northeast of Cumberland; along Flintstone Creek in Gilpin; on National Road in Gilpin west of Lock No. 56 at Great Cacapon; ¼ mile north of Green Spring Furnace; west of iron bridge over Town Creek northeast of Oldtown; on National Road ½ mile west of Licking Creek; on road east of Pine Hill about 4 miles north of Oldtown; east side Warrior Mt. east of Rush; B. & O. R. R. cut at Hancock Station, W. Va.; on road about half way between Romney and Hanging Rock, W. Va.; on the Romney-Hanging Rock Road about ½ mile north of Romney, W. Va.; 1 mile north of Romney, W. Va.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

CHONETES CORONATUS (Conrad)

Plate XI, Figs. 18-21

Strophomena carinata Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 257, pl. xiv, fig. 13.
Strophomena syrtalis Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 253, pl. xiv, fig. 1.
Chonetes coronata Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 146, figs. 1, 2.
Chonetes coronata Hall, 1867, Pal. N. Y., vol. iv, p. 133, pl. xxi, figs. 9-12.
Chonetes coronata Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Chonetes coronata Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pl. xvi, figs. 10, 11, 24, 26, 33, 39, 41, 43.
Chonetes coronatus Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 173.
Chonetes carinatus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 209.
Chonetes coronatus Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 236, fig. 288.

Description.—Shell large, broadly elliptical, some of the single valves approaching a rectangular form; the hinge-line is sometimes shorter than the width of the shell and the cardinal angles rounded, but generally it is nearly or quite equal to the greatest width of the shell with the lateral margins nearly rectangular to the hinge-line; the cardinal angles are sometimes produced in short acute auriculate extensions. Ventral valve varying from moderately convex in the younger shells, to very gibbous in the older ones; sometimes a little flattened below the umbo and this space gradually widens toward the front, more frequently there is a shallow undefined sinus along the middle of the valve; the outline of the valve is regularly convex, but abruptly depressed towards the cardinal extremities, which are flattened and a little deflected toward the ventral side; the cardinal margin has from five to seven oblique spines on each side of the apex, although they are usually not preserved on the Maryland specimens, and the cardinal area is narrow. Dorsal valve is variably concave, sometimes following nearly the contour of the ventral valve, but often moderately concave or nearly flat in the middle and upper part, and more suddenly deflected towards the front and lateral

margins, while the cardinal extremities are flattened; the cardinal area is linear. Surface is marked by numerous closely arranged slender subequal striae, which are bifurcated or increased by intercalation, and are continued on the cardinal extremities to within a short distance of the hinge-line; on an average specimen there are 12 striae in the space of 5 mm. The interior of the ventral valve shows diverging dental lamellae and a narrow median ridge, while beyond the muscular and vascular areas the surface is strongly pustulose in both valves. In some of the Maryland specimens from the somewhat arenaceous shales, particularly from McCoys Ferry, the internal impressions show the reverse of the above characters in a median depression, diverging dental impressions, deeply pitted surface outside of the vascular markings, and strongly striate margin.

This species occurs in abundance at McCoys Ferry largely in the form of internal impressions which differ in no respect from New York specimens found in similar deposits; the R. R. cut at 21st Bridge and Evitts Creek below Wolfe Mill furnished specimens in which the shell is preserved; while about 2 miles north of Hancock on the road from Hancock to Harrisonville, Pa., specimens are common some of which are smaller than the majority, show four or five cardinal spines and resemble figs. 10*a* and 10*b* on pl. xxi, vol. iv, Palæontology of New York. There is apparently no difference in characters between the Maryland specimens and the several forms of the species found in New York. It is readily distinguished by its large size, convex ventral valve with the frequent shallow sinus, numerous closely arranged surface striae, while the pustules and striae are characteristic of the outer portion of the inside of the valves or internal impressions.

Length, 10-20 mm.; width, 13-28 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road, 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill; Williams Road, ¼ mile east of Queen City Hotel, Cumberland; in Jennings Run, ½ mile west of Corriganville; B. & O. R. R. cut at 21st Bridge; on National Road, ½ mile west of Tonoloway Ridge; on the Hancock-Harrisonville Road about 2 miles north of Hancock;

McCoys Ferry; Ernstville; in run at Hancock east of Catholic church; along Flintstone Creek in Gilpin; west of Lock No. 56 at Great Cacapon; ½ mile north of Green Spring Furnace; B. &. O. R. R. cut at Hancock Station, W. Va.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

CHONETES SCITULUS Hall

Plate XII, Figs. 1-8

Chonetes scitula Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 147.
Chonetes scitula Hall, 1867, Pal. N. Y., vol. iv, pp. 130, 141, pl. xxi, fig. 4; pl. xxii, figs. 6-11.
Chonetes scitula Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pl. xvi, figs. 3, 4, 27, 32, 40, 44.
Chonetes scitulus Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 178.
Chonetes scitulus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 212.
Chonetes scitulus Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 237, figs. 289a, b.

Description.—Shell semioval; hinge-line often not quite equaling the greatest width of the shell. Ventral valve moderately gibbous in the middle and regularly curving to the front and lateral margins; the gibbous portions narrowing towards the hinge-line, and the umbo little elevated; abruptly depressed towards the cardinal angles, which are nearly flat; cardinal area narrow and wider in the middle; delthyrium partially closed by a convex deltidium and the aperture filled by the cardinal process of the opposite valve; margin provided with from 12 to 14 spines; the interior shows a slender median ridge and two strong dental lamellae. Dorsal valve with a concavity less than the convexity of the opposite valve; cardinal angles flat; cardinal area linear, half as wide as that of the opposite valve; the interior is strongly pustulose, with a somewhat broad depression along the center, in the middle of which there is a slender mesial ridge. Surface marked by fine subequal striae which are sometimes sharp and angular, sometimes rounded and often alternate in size toward the margin; of these 15 to 20 may be counted near the beak, while from bifurcation and intercalation there are from

50 to 60 on the margin; fine concentric striae are visible on well-preserved specimens.

There are specimens in Maryland which in size, outline and other characters agree closely with the specimens figured by Hall from the New York Hamilton and stated to represent specimens of the ordinary proportions (see figs. 4*a* and 4*b*, pl. xxi, vol. iv, Pal. N. Y.). Other specimens are perhaps twice the size of the former, but with the same general characters, which are also referred to this species. Numerous specimens of this size and general appearance have been collected by the writer in the Hamilton and Ithaca formations of New York which he has considered as belonging to this species. In the office of the New York State Paleontologist are specimens from the Hamilton shales of that state labelled *Chonetes scitulus* which are fully as large as any of the Maryland specimens and marked by from 50 to 60 striae. The result of this comparison apparently shows that the larger as well as the smaller Maryland specimens belong to this species. Some of the best specimens of this larger form were found in a bluish argillaceous shale on the West Virginia side of the Potomac between 3 and 4 miles south of Cumberland; other good specimens were found at Ernstville in Washington County. This species is distinguished by its outline, considerably greater width than length, the large number of striae (from 50 to more than 60) at the margin and the obliquely directed cardinal spines.

Length, 6-8 mm.; width, 9-11 mm.

Length large specimen, 9-10 mm.; width, 15-16 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge (?). Williams Road, 3½ miles southeast of Cumberland (?); on National Road, ½ mile west of Tonoloway Ridge; B. & O. R. R. cut at 21st Bridge; on Oldtown Road, east of Maryland Ave., Cumberland; McCoys Ferry; southwest of McCoys Ferry; on the Hancock-Harrisonville Road about 2 miles north of Hancock; Ernstville; on National Road northeast of Cumberland; in run at Hancock, east of Catholic church; along Flintstone Creek in Gilpin; west of iron bridge over Town Creek northeast of Oldtown; B. & O. R. R. cut opposite Hancock, W. Va.; on road about half way between Romney and Hanging

Rock, W. Va. (?); 1 mile north of Romney, W. Va.; on the Romney-Hanging Rock Road about ½ mile north of Romney, W. Va.; W. Va. side Potomac River 3 and 4 miles south of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

CHONETES SETIGER (Hall)

Plate XI, Figs. 22-25

Strophomena setigera Hall, 1843, Geol. N. Y., pt. iv, p. 180, fig. 2, p. 222, fig. 3.
Chonetes setigera de Koninck, 1847, Recher. Animaux Foss., vol. i, p. 215, pl. xx, fig. 7.
Chonetes setigera Hall, 1867, Pal. N. Y., vol. iv, p. 129, pl. xxi, fig. 2; p. 142, pl. xxii, figs. 1-5.
Chonetes setigera Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pl. xvi, figs. 2, 5, 19.
Chonetes setigerus Schuchert, 1897, Bull. U. S. Geol. Surv. No. 87, p. 178.
Chonetes setiger Clarke, 1904, N. Y. State Mus., Mem. 6, p. 376.
Chonetes setigerus Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 237, fig. 289a.

Description.—Shell semielliptical; the hinge-line equaling the greatest width of the shell, and rarely extending beyond. Ventral valve moderately convex, rarely a little gibbous in the middle; umbo scarcely rising above the hinge-line; the greatest elevation is above the middle of the shell and it gradually slopes toward the front and lateral margins becoming flattened on the cardinal angles; the cardinal margin generally has three slender tubular spines on each side of the apex, which are bent a little outward as they leave the shell, and then rise almost vertically, or with a slight curve from the direction of the hinge-line. The striae are slender rounded or subangular, increasing by bifurcation and intercalation so that there are from 36 to 50 on the margin. On well preserved specimens the radial striae are crossed by fine concentric ones.

Among the Maryland specimens there are forms similar to those figured by Hall on plates 21 and 22, vol. iv, Palæontology of New York; and other specimens somewhat larger which agree with similar forms from the Hamilton and Ithaca formations of New York which have been referred by H. S. Williams and other paleontologists to this

species. The species is characterized by its form, moderate convexity, nearly vertical cardinal spines and medium number of rounded or subangular striae. It is readily distinguished from *C. mucronatus* by the more numerous striae, which are also more angular and bifurcate more frequently, as well as the direction of the cardinal spines. It is more closely related to *C. scitulus,* but it differs in its greater proportional length, by the smaller number of rounded, coarser striae, the usually greater convexity of the ventral valve towards the apex and the smaller number and vertical direction of the cardinal spines.

Length, medium specimen, 7 mm.; width, 8 mm.: Large specimen, length, 8-11 mm.; width, 10-12 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge. Williams Road, 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill (?); in Jennings Run, ½ mile west of Corriganville; on National Road, ½ mile west of Tonoloway Ridge; B. & O. R. R. cut at 21st Bridge; on Oldtown Road, east of Maryland Ave., Cumberland; McCoys Ferry; southwest of McCoys Ferry; on the Hancock-Harrisonville Road about 2 miles north of Hancock; Ernstville; on National Road northeast of Cumberland; in run at Hancock east of Catholic church; along Flintstone Creek in Gilpin; west of Lock No. 56 at Great Cacapon; west of iron bridge over Town Creek northeast of Oldtown; on National Road, ½ mile west of Licking Creek; W. Va. side Potomac River about 3 miles south of Cumberland (?); B. & O. R. R. cut at Hancock Station, W. Va.; on road about half way between Romney and Hanging Rock, W. Va.

Collections.—Maryland Geological Survey; American Museum of Natural History.

CHONETES LEPIDUS Hall

Plate XII, Figs. 9-13

Chonetes lepida Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 148.
Chonetes lepida Hall, 1867, Pal. N. Y., vol. iv, pp. 132, 142, pl. xxi, figs. 5a-5e; pl. xxii, figs. 12, 13.
Chonetes lepidus Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 175.
Chonetes lepidus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 211.
Chonetes lepidus Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 237, figs. 289d, e.

Description.—Shell small; semielliptical to subhemispherical; hinge-line about equaling the width of the shell below. Ventral valve more or less gibbous, with a longitudinal depression along the center in well marked specimens; curving abruptly to the front and sides, with cardinal angles scarcely flattened; cardinal area narrow and distinctly wider in the middle; the delthyrium is small, partially closed by a pseudo-deltidium, and filled by the cardinal process of the opposite valve; there are generally two or three spines on each side of the center of the cardinal line and in some specimens five are shown. Dorsal valve follows the curvature of the ventral valve, with a lesser concavity; cardinal area scarcely equal to the thickness of the shell; the interior shows a longitudinal depression, and the course of the striae is well defined and strongly papillose. Surface marked by rather strong angular bifurcating striae, of which there are ten or twelve near the umbo and twice as many or more on the margin; two of the striae, on each side of the center near the beak of the ventral valve, are generally larger and more prominent than the others, the space between them is depressed and occupied by two or three smaller striae, which are given off from the larger ones on each side.

Among the numerous specimens of *Chonetes* from the Romney rocks of Maryland are a considerable number of a small form which agree quite closely with the above description. The number of striae on the margin runs up to 24 but frequently bifurcation almost at the margin considerably increases the number. They are stronger than those of *C. setiger* or *C. scitulus,* and the impressions of some of the ventral valves apparently show two stronger striae near the center with the depressed area between them occupied by smaller striae; others, however, apparently do not show this depression. There are also specimens which are difficult to separate and it appears to the writer that Nicholson's opinion [1] that this species is the young of *C. scitulus* may be correct. An examination of the specimen from the Marcellus shale represented by figure 12 on pl. xxii, vol. iv, Palæontology of New York, shows that there are about 36 striae near the margin of the shell, while the central depressed area is no more

[1] Rept. Palæontology Province Ontario, 1874, p. 74.

conspicuous than on part of the Maryland specimens. Internal impressions from the Hamilton shales of New York in the office of the State Paleontologist labeled *Chonetes lepidus* are as large and identical in all particulars with similar specimens from Maryland. The characteristics of the species are its small size, the longitudinal mesial depression of the ventral valve, bounded on each side by larger and more prominent striae with smaller ones between, and the rather strong bifurcating striae, of which there are ten or twelve near the umbo and twice as many or more on the margin.

Length, 2½-6 mm.; width, 3-7 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Hanging Rock, W. Va. (?). HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge. East bank Evitts Creek below Wolfe Mill; Town Creek Road at Geo. Diefenbaugh's (?); on National Road ½ mile west of Tonoloway Ridge; B. & O. R. R. cut at 21st Bridge; Williams Road 3½ miles southeast of Cumberland; McCoys Ferry; on National Road northeast of Cumberland; in run at Hancock east of Catholic church; along Flintstone Creek in Gilpin; on National Road in Gilpin; ¼ mile north of Green Spring Furnace; west of iron bridge over Town Creek northeast of Oldtown; on the Romney-Hanging Rock Road, about ½ mile north of Romney, W. Va.; W. Va. side Potomac River about 3 miles south of Cumberland; B. & O. R. R. cut at Hancock Station, W. Va.; on road about half way between Romney and Hanging Rock, W. Va.

Collections.—Maryland Geological Survey; American Museum of Natural History.

CHONETES VICINUS (Castelnau)

Plate XII, Figs. 14-21

Leptaena vicina Castelnau, 1843, Systeme Sil. l'Amérique Septentrionale, p. 39, pl. xiv, fig. 9.

Chonetes vicina de Koninck, 1847, Recher. Animaux Foss., pt. i, p. 203.

Chonetes deflecta Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 149.

Chonetes deflecta Hall, 1867, Pal. N. Y., vol. iv, p. 126, pl. xxi, figs. 7, 8.

Chonetes deflecta Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pl. xvi, fig. 28.

Chonetes vicinus Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 180.

Chonetes vicinus Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii. p. 236, fig. 287.

Description.—Shell semielliptical; length and width as four to five or eight to nine, but rarely proportionally wider. Ventral valve extremely gibbous, regularly arched, the greatest elevation being about the middle of the length; abruptly depressed towards the cardinal angles, which are flattened, with the extremities deflected to the ventral side; the umbo is slightly elevated above the cardinal margin; cardinal area narrow; the interior shows strong dental lamellae, a somewhat angular median ridge terminates above the middle of the valve, and the surface is finely pustulose in the middle, a little more coarsely pustulose along the deflected line and nearly or quite smooth towards the margins. Dorsal valve deeply concave, but not equaling the convexity of the ventral valve; cardinal area more than half as wide as that of the ventral valve; the interior surface beyond the vascular impressions is covered by elongate papillae, the marks of the striae being scarcely distinct. Surface marked by from twenty-six to thirty-four subangular or sometimes rounded striae which are often irregularly increased by bifurcation or intercalation towards the margin; in those with fewer striae, they are sharper and only half as wide as the interspaces, while in those with a larger number, the striae and interspaces are equal; there is a considerable space at the cardinal angles of each valve destitute of striae. Hall stated that the examination of large numbers of specimens showed so many extreme varieties that it appeared difficult to indicate reliable characters for separating this species from *C. mucronatus*. The principal difference appeared to be in the larger number of striae on the specimens referred to *C. deflecta* = *C. vicinus*.

Among the Maryland specimens of *Chonetes* are rather poorly preserved impressions which resemble this species more closely than any other. The ventral valves are gibbous, the cardinal angles flattened, the striae about thirty-four in number, and the interior of the valves pustulose. One rather large and gibbous ventral valve, which is partly exfoliated, shows about 36 striae across the central part of the shell which are considerably increased in number by bifurcation by the time the margin is reached. On the well preserved portion of the shell near the umbo the radiating striae are crossed by numerous, fine, thread-like concentric striae, which

are close together. On comparison it was found that the radiating striae on the Maryland specimens were finer than on specimens of this species from the Hamilton shales of New York. This species is distinguished by its strong convexity, semielliptical outline, deflected cardinal angles, and finer, more numerous and more closely crowded striae than in *C. mucronatus*.

Length, 10 mm.; width, 12 mm. Another specimen has the following proportions: Length, 10 mm.; width, 11 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; McCoys Ferry; southwest of McCoys Ferry; along Flintstone Creek in Gilpin; west of iron bridge over Town Creek northeast of Oldtown; on road about half way between Romney and Hanging Rock, W. Va.

Collections.—Maryland Geological Survey; American Museum of Natural History.

CHONETES MARYLANDICUS n. sp.

Plate XIII, Figs. 1-6

Description.—Shell medium size, semielliptical, hinge-line as long or slightly shorter than the greatest width of the shell. Ventral valve gibbous, the central part having the greatest convexity, from which it declines rapidly towards the front and is abruptly depressed towards the lateral margins and cardinal angles, the latter being flattened. The bases of at least three spines are shown on each side of the umbo, and the spines are either straight or inclined laterally; cardinal area rather narrow, but wider than that of the opposite valve. Dorsal valve moderately concave, not equaling the convexity of the ventral valve. Surface of dorsal valve marked by from 34 to 60 rounded or sometimes subangular striae which increase by bifurcation and sometimes by intercalation, so that there may be even a larger number on the ventral margin, and the striae and interspaces are covered by very fine radiating, thread-like striae, while well preserved surfaces show similar, closely arranged, thread-like concentric ones. Striae of ventral similar to those of dorsal valve. Interior of ventral valve has a median ridge which extends from the beak for

about two-thirds its length and the interiors of both valves have numerous and closely arranged small pustules.

The most distinctive specific character of this species is the large number of radiating, thread-like striae which cover both the coarser striae and the interspaces. It most closely resembles *C. vicinus* (Castelnau) but differs from that species in the larger number of striae and especially in the fine radiating ones.

Length, 6-9 mm.; width, 10-12 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge.

Collection.—Maryland Geological Survey.

CHONETES RUGOSUS Kindle

Plate XIII, Figs. 7-9

Chonetes rugosus **Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 72, pl. iv, figs. 5-7.**

Description.—Shell medium size transverse in outline, slightly convex on the ventral side. Surface marked by fine closely placed striae numbering about 100. All of the striae bifurcate before reaching the margin, some of them repeatedly. Six to ten concentric undulations or corrugations cross the striae. These are strongest in the median and anterior portions of the shell and die out toward the anterior margin. The hinge-line is mucronate, the extremities extending considerably beyond the sides of the shell. A strong rib-like process or pseudo hinge-line arises from the hinge-line about midway between the beak and the extremity of the mucronate extension of the hinge-line. This curves very gently upward from the hinge-line and extends to or beyond its extremities. A peculiar nonstriated, ear-like process is subtended between the hinge-line proper and the pseudo hinge-line. This, on the inner surface, is marked by a series of closely spaced diagonal denticulations. Dorsal valve and internal characters are unknown.

The peculiar denticulated ear-like expansion posterior to the hinge-line distinguishes this from any other *Chonetes*. A single specimen doubtfully referred to this species shows two short outward directed spines

on each side of the beak. Ordinary spines have not been observed on any other specimens referred to this species.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Genus ANOPLIA Hall and Clarke

ANOPLIA NUCLEATA (Hall)

Plate XIII, Figs. 10-13

Leptaena nucleata **Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 47.**
Leptaena ? nucleata **Hall, 1859, Pal. N. Y., vol. iii, p. 419, pl. 94, fig. 1.**
Anoplia nucleata **Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 73, pl. v, figs. 8-11.**

Description.—Shell small, concavo-convex, and strongly arched. Surface without striae or plications. Interior of both valves strongly pustulose. Ventral valve very gibbous in the umbonal and median region, beak incurved. In the interior a strong septum extends from the beak about one-third the distance to the front of the shell. In nearly all specimens this septum terminates abruptly. In a few individuals, however, it is continued forward a short distance beyond its normal terminus as a pair of rather faintly developed, divergent, y-shaped arms. Most of the specimens from Mendota, Virginia, show moulds of the spine tube. This extremely slender tube originates on the inner surface of the shell, midway between the beak and the cardinal angle just inside the inner margin of the area, and crosses diagonally the marginal portion of the valve with a slight curve. It terminates at the side of the beak in a minute point apparently not reaching the outer surface of the shell.

Dorsal valve moderately and regularly concave. Outer surface marked by a minute tripartite median process just inside the hinge-line. This comprises two short divergent lobes and a third median lobe stronger than the lateral one, having a length of about ⅓ of a mm. The interior of this valve is characterized by two slender sharp median ridges. These diverge slightly as they extend forward from the base of the cardinal process and terminate about ⅔ the distance from the hinge-line to the front. A

narrow, elongate, muscular scar occupies the posterior half of the space between these ridges. Outside this pair of median ridges is a second pair of poorly defined and very divergent ridges which appear to mark the outer limits of muscular areas.

The peculiar, short, tripartite process on the exterior of the dorsal valve of this shell was correctly figured by Hall and Clarke[1] in their work on the Brachiopoda, but in the latest figures of this shell which have appeared Dr. Clarke has figured as the interior of a dorsal valve[2] (Pl. 41, Fig. 16) a specimen which evidently represents a mould of the exterior of the valve.

This species occurs in the Onondaga fauna throughout the middle Allegheny region.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Tonoloway, Maryland, 1¾ miles south of Berkeley Springs, West Virginia.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Genus STROPHALOSIA King

STROPHALOSIA TRUNCATA (Hall)

Plate XIII, Figs. 14-16

Strophomena pustulosa Hall, 1843, Geol. N. Y., pt. iv, p. 180, fig. 4. (Not *Productus pustulosus* Phillips.)
Productus truncatus Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 171.
Productella truncata Hall, 1867, Pal. N. Y., vol. iv, p. 160, pl. xxiii, figs. 12-24.
Productella (*Strophalosia* (?)) *truncata* Whiteaves, 1889, Cont. Canadian Pal., vol. i, p. 112, pl. xvi, figs. 1, 2.
Strophalosia truncata Beecher, 1890, Am. Jour. Sci., 3d ser., vol. xl, p. 241.
Strophalosia truncata Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, p. 316, pl. xv B, figs. 24-26; pl. xvii, figs. 10-15.
Strophalosia truncata Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 419.
Strophalosia truncata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 330.
Strophalosia truncata Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 240, fig. 292.

Description.—Shell small, concavo-convex; hinge-line equaling or less than the greatest width of the shell. Ventral valve gibbous in the

[1] Pal. New York, vol. viii, pt. i, 1892, pl. xx, fig. 16.
[2] Mem. New York State Mus. Nat. Hist., No. 9, 1908.

middle, broadly truncate on the umbo, regularly curving to the front, abruptly depressed at the sides, and forming narrow flattened ears at the cardinal extremities. Dorsal valve moderately concave, minutely truncate at the apex, the interior wrinkled and pustulose with a conspicuous depression at the umbo, and a short bifurcating cardinal process. Surface of the ventral valve wrinkled at the hinge-line, marked by a greater or less number of spiniferous ridges, supporting slender spines of moderate length; there is usually a row of two or three spines on the ears just below the hinge-margin, and they are often closely arranged about the limits of the truncation on the umbo, and more sparsely on the middle and front part of the valve; the dorsal valve is wrinkled along the hinge-line, and the surface covered by numerous elongate spiniferous pustules, bearing, when perfect, long slender spines

This species is not common in Maryland but the argillaceous shales of Evitts Creek below Wolfe Mill have furnished several specimens of dorsal valves as well as the dark gray impure limestone at the iron bridge, 4½ miles northeast of Oldtown. Part of the specimens are internal impressions of the dorsal valve which show very well its wrinkled and pustulose character. The specimens agree quite closely with some of the type specimens from New York, especially with the one represented by fig. 23 on pl. xxiii, vol. iv, Palæontology of New York. A gibbous ventral valve from the Williams Road about ¼ mile east of the Queen City Hotel, Cumberland, is referred to this species although it is not conspicuously truncated and there are four spines in the row just below the hinge-line, but the surface shows a number of ridges upon which at some distance apart are bases of spines. This species is recognized by its small size, gibbous and truncate ventral valve, flattened cardinal extremities, slightly concave dorsal valve which is wrinkled and pustulose on the interior, and the scattered surface spines on both valves.

Kindle states that this is a very common and widely distributed species of the Onondaga fauna, occurring both in the soft shales and the hard limestone beds.

Length, 3-9 mm.; width, 3-12 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. W. Va. Cent. R. R. cut at 21st Bridge. MARCELLUS MEMBER. Williams Road, 3½ miles southeast of Cumberland. HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; Williams Road about ¼ mile east of the Queen City Hotel.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History; U. S. National Museum.

Genus PRODUCTELLA Hall

PRODUCTELLA cf. SPINULICOSTA Hall

Plate XIII, Fig. 17

Productus spinulicostus **Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 173.**

Productella spinulicosta **Hall, 1867, Pal. N. Y., vol. iv, p. 160, pl. xxiii, figs. 6-8, 25-34.**

Productella spinulicosta **Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pl. xvii, figs. 3-6.**

Productella spinulicosta **Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 318.**

Productella spinulicosta **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 292.**

Productella spinulicosta **Grabau and Shimer, 1907, N. Am. Index Fossils, vol. ii, p. 241, figs. 293c, d.**

Description.—"Shell broad, semielliptical or somewhat orbicular; hinge-line generally a little less than the greatest width of the shell. Ventral valve varying in shells of different size, from moderately to extremely gibbous in the middle, with the beak strongly incurved. Dorsal valve moderately concave in its upper part, and becoming more concave or arcuate towards the front. Surface marked by fine strong concentric striae, which are sometimes crowded and wrinkled on the body of the shell. There are several rows of interrupted ridges or spine-bases, which in entire specimens support slender spines. The ears are strongly wrinkled, and support a row of four or five spines just below the hinge-line." Hall, 1867.

A small and somewhat imperfect ventral valve of *Productella* was found in the Maryland collection which at least may be compared with this species and probably belongs to it. The valve is strongly gibbous in the central part. There is no truncation of the umbo or evidence of its

having been attached by the surface, which is marked by concentric lines varying in strength from striae to wrinkles and interrupted radiating ridges which at intervals bear spine bases. The preserved ear is strongly wrinkled and shows a conspicuous row of four spines just below the hinge-line. It will be seen that the characters shown by this single valve agree very well with those enumerated by Hall in his description of the species. The specimen was submitted to Prof. Charles Schuchert, who reported it to be "a *Productella* and very probably *P. spinulicosta.*"

Length, 9 mm.; width, 8 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road ¼ mile east of Queen City Hotel, Cumberland.

Collection.—Maryland Geological Survey.

PRODUCTELLA (?) SCHUCHERTI n. sp.

Plate XIII, Fig. 21

Description.—Shell of moderate size; hinge-line equaling the greatest width of the shell. Ventral valve convex, the greatest convexity toward the umbonal region; gradually sloping toward the front and lower lateral margins, and abruptly depressed and flattened towards the cardino-lateral margins. Surface marked by about 100 fairly large striae extending almost to the cardinal extremities, which are slightly undulating and increase by bifurcation. There are faint concentric striae and an occasional wrinkle or line of growth.

The specimens of this species consist of an imperfect ventral valve and a fragment of another valve; but as it probably carries a form related to the group *Lineati* of the Carboniferous *Productus,* back into the Middle Devonian, it is thought worthy of description. The specimens were submitted to Dr. J. M. Clarke and Prof. Schuchert. Dr. Clarke said that they suggested *Productella* of the Carboniferous. Prof. Schuchert wrote as follows: "These are not *Chonetes* since there are no hinge spines nor indications of shell punctures. The general form, striae and concentric markings indicate *Productus* of the type of *P. cora.* If this is so it is very interesting in extending the line of this prominent group of *Productus.* This type of *Productus* begins well developed in the Kinder-

hook [Mississippian] so that one can look for the ancestors in the Devonian. It is probably the most interesting Brachiopod in the Maryland collection. If you describe it as new, and it seems to be worthy, place it in *Productella* (?)."

Length, 19 mm.; width, 20 mm.

Named in honor of Prof. Charles Schuchert, of Yale University.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Ernstville.

Collection.—Maryland Geological Survey.

Family ORTHIDAE

Genus DALMANELLA Hall and Clarke

DALMANELLA LENTICULARIS (Vanuxem)

Plate XIII, Figs. 22-25; Plate XIV, Figs. 11, 12

Orthis lenticularis **Vanuxem, 1842 (non Wahlenberg), Geology New York Survey, Third Geol. Dist., p. 139, fig. 4.**

Dalmanella lenticularis **Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 79, pl. v, figs. 12-16.**

Description.—Shell suborbicular, subplano-convex. Cardinal angles obtuse or rounded. Greatest width of shell about one-fourth greater than length of hinge-line. Ventral valve with a subcarinate, gently rounded, median elevation from which the shell slopes regularly to each side. A well developed muscular impression bordered laterally by strong hinge teeth characterizes the interior. The dorsal valve is depressed convex, with a shallow but distinct mesial depression extending the length of the shell. A strongly marked muscular scar extends to the middle of the valve. A broad, low, and sometimes indistinct median ridge divides it longitudinally. Posteriorly it terminates in a bifurcated cardinal process. The entire surface is covered by coarse bifurcating striae, somewhat irregular in size, which are grouped in fascicles of four or five. These are crossed by fine concentric striae. The specimens in this fauna are somewhat smaller than those figured by Hall.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road 3½ miles northeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Genus RHIPIDOMELLA Oehlert

RHIPIDOMELLA VANUXEMI Hall

Plate XIII, Figs. 26-29

Orthis vanuxemi Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 135, figs. 1-7.

Orthis vanuxemi Hall, 1867, Pal. N. Y., vol. iv, pp. 40, 47, pl. v, fig. 6; pl. vi, figs. 3*a*-3*r*.

Orthis vanuxemi Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.

Rhipidomella vanuxemi Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. 1, p. 225, pl. vi, figs. 14, 15; pl. vi A, figs. 7, 8.

Rhipidomella vanuxemi Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, pp. 352, 353.

Rhipidomella vanuxemi Clarke, 1903, N. Y. State Mus., Bull. 65, p. 299.

Rhipidomella vanuxemi Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 265, figs. 320a-c.

Description.—Shell subcircular or transversely suboval, compressed; hinge-line very short; margins of the valves crenulated within from the external striae; interior minutely punctate. Ventral valve nearly flat or a little concave towards the front, moderately convex in the umbonal region; beak small extending little beyond the opposite one; cardinal area very small, less than half the greatest width of the shell; delthyrium comparatively large, triangular and partly filled by cardinal process of opposite valve; the teeth are prominent and the interior of the valve is marked by a large flabelliform diductor impression, which reaches from one-half to two-thirds the length of the shell and in the median line is the adductor impression. Dorsal valve convex; beak scarcely distinct from the cardinal border; cardinal process prominent, which is continued in a rounded median ridge for half the length of the shell. Surface marked by fine, closely arranged, radiating tubular striae, which are perforate at intervals and increase both by implantation and bifurcation. These are crossed by fine concentric striae and at greater intervals by concentric, imbricating lines of growth; entire surface when magnified granulate or punctate.

There are specimens of this shell as well as internal impressions which practically agree almost precisely with specimens from the Hamilton shales of New York. It was also reported by Hall from Maryland and

Virginia[1] and "a cast of a ventral valve supposed to be of this species, from Cumberland, Md.," was figured,[2] which was apparently repeated in volume 8 without question regarding its specific identity.[3] This species is distinguished by its subcircular or transversely suboval outline, ventral valve nearly flat or slightly concave becoming moderately convex near the beak, with large muscular area in its interior, dorsal valve convex.

Length, 27 mm.; width, 29 mm.

Kindle states that the specimens of the Onondaga fauna which are referred to this species are somewhat smaller than the average size of the species as seen in the Hamilton, seldom exceeding a length of 14 and a width of 16 mm. In other features than size they correspond closely to the ordinary type of this shell.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Tonoloway. HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; Williams Road, ¾ mile east of Queen City Hotel, Cumberland; Williams Road, ¼ mile east of Queen City Hotel, Cumberland; Ernstville.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

RHIPIDOMELLA LEUCOSIA Hall

Plate XIV, Figs. 1-5

Orthis leucosia Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 80.
Orthis leucosia Hall, 1867, Pal. N. Y., vol. iv, pp. 48, 63, pl. vii, figs. *4a-4i;* pl. viii, figs. 9, 10.
Orthis leucosia Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Rhipidomella leucosia Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, p. 225, pl. vi, fig. 16; pl. vi A, fig. 9.
Rhipidomella leucosia Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 349.
Rhipidomella leucosia Clarke, 1903, N. Y. State Mus., Bull. 65, p. 298.
Rhipidomella leucosia Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 265, figs. 320 d, e.

Description.—Shell broadly ovate, greatest width below the middle, somewhat obtusely pointed at the beak; cardinal area short and small, being less than half the width of the shell; beaks approximate. Ventral

[1] Pal. N. Y., vol. iv, p. 48.
[2] *Ibid.*, pl. 6, fig. 3*r*.
[3] *Loc. cit.*, pt. i, pl. vi, fig. 15.

valve gibbous towards the umbo, depressed convex in the center and flattened towards the front; the front margin straight, or without sinus; delthyrium very broad, nearly twice as wide as high. Dorsal valve the more gibbous, the greatest convexity above the middle, longitudinally marked by a median depression which is sometimes obsolete; the interior shows a prominent cardinal process, which is continued in a strong median ridge for about one-half the length of the valve. Surface marked by fine, radiating, bifurcating striae, which are crossed by finer concentric ones, and by more distant subimbricating lamellose lines of growth; minute tubular openings occur on the surface of the striae; the external striae usually mark the inner margins of the valves.

Hall noted the close agreement of this species with *R. vanuxemi*, but stated that it differed in being more ovate in shape, the cardinal extremities are less rounded, the sides slope almost directly nearly to the middle of the shell and the dorsal valve is more gibbous. He referred specimens from Cumberland, Md., to this species and figured an internal impression of a ventral valve which was stated to be "probably of this species."[1] Comparatively few specimens of this species were found in Maryland; but there are a few impressions which show at least a part of its distinctive characters and apparently ought to be referred to this species. As already stated the species closely resembles *R. vanuxemi* but these impressions differ from that species in their more ovate outline, greater convexity of valves, and more pointed posterior end.

Length, 32 mm.; greatest width, 32 mm.; width on hinge-line, 9 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road, ¾ mile east of Queen City Hotel, Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

RHIPIDOMELLA PENELOPE Hall

Plate XIV, Figs. 6-9

Orthis penelope Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 79, figs. 1, 2.

Orthis penelope Hall, 1867, Pal. N. Y., vol. iv, p. 50, pl. vi, figs. 2*a*-2*m*.

[1] Pal. N. Y., vol. iv, pl. vii, fig. 4*i*.

Rhipidomella penelope Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pp. 211, 225, pl. vi, figs. 6-13; pl. vi A, figs. 10, (? 11).
Rhipidomella penelope Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 351.
Rhipidomella penelope Clarke, 1903, N. Y. State Mus., Bull. No. 65, p. 298.
Rhipidomella penelope Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 265, figs. 320f, g.

Description.—Shell large, oblate, proportions of length and breadth about as four to five, plano-convex; hinge-line about two-fifths the width of the shell. Ventral valve depressed-convex above, sometimes a little gibbous towards the umbo, flat or often concave in the middle and below, the front without sinuosity; the interior marked by a subcircular or broadly ovate flabellate muscular impression, which occupies more than half the length and breadth of the valve. Dorsal valve regularly convex, the greatest convexity about the center, with a very slight mesial depression or flattening along the center; the interior shows a prominent cardinal process, which is continued in a median ridge sometimes nearly to the front of the shell. Surface marked by fine radiating bifurcating striae, which are arched upwards near the cardinal extremities, and crossed by fine concentric lines as well as lamellose lines of growth, the radiating striae frequently have the appearance of being broken or interrupted, from the peculiar manner in which the pores open upon the surface.

This species is apparently rare in Maryland; but a large, although broken, specimen from Evitts Creek below Wolfe Mill is referred to it. The species was identified by Hall from Cumberland, Md., and "a cast of the dorsal valve" from that locality figured.[1] This species is quite similar to *R. vanuxemi* but is generally considered larger, the striae are stronger, the tubular openings of the striae are more elongate, and the muscular area smaller and more rounded.

Length, 33 mm.; width, 38 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill (?).

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

[1] Pal. N. Y., vol. iv, pl. vi, fig. 2*m*.

RHIPIDOMELLA CYCLAS Hall (?)

Plate XIV, Fig. 10

Orthis cyclas **Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 78.**
Orthis cyclas **Hall, 1867, Pal. N. Y., vol. iv, p. 52, pl. vii, figs. 2, 3.**
Rhipidomella cyclas **Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, p. 225.**
Rhipidomella cyclas **Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 348.**

Description.—Shell rather small, transversely subelliptical to subquadrate, the specimens from Ernstville, Md., are subelliptical while those from Hanging Rock, W. Va., are more quadrate in outline. Valves rather flat with greatest gibbosity near the umbo; cardinal line about one-half the greatest width of the shell. Surface marked by strong and prominent striae which increase both by bifurcation and implantation, and one specimen shows fine thread-like concentric striae which are thickest toward the front of the shell. Shell structure strongly and finely punctate.

But few specimens of this form were found in Maryland and West Virginia and they are doubtfully referred to this species. On account of the size, prominent striae and some other characters the specimens from Hanging Rock, West Virginia, were at first referred to this species with a query. The specimens from Ernstville, Md., are broader than *Rhipidomella vanuxemi* Hall, which they resemble somewhat, a character which appears to be constant and not produced by pressure. Dr. Clarke after examining the specimens said "they are perhaps *R. vanuxemi* distorted by pressure, still the breadth appears to be constant and perhaps they are entitled to be called a new species." The Ernstville specimens were submitted to Prof. Schuchert, who wrote me "I think they are *Rhipidomella cyclas* Hall. If your other specimens have a long hinge-line, or at least longer than *R. vanuxemi*, they are *R. cyclas*." The specimen from Williams Road which is figured was examined by Dr. J. M. Clarke, who said that "it is as good a *Rhipidomella cyclas* as any of the New York Hamilton specimens. It is not known, however, what this species is and perhaps it is only the young form of *R. vanuxemi*." The figured specimens from Ernstville and Williams Road, Md., and from Hanging Rock, W. Va., were also examined by Dr. Grabau, who agreed in comparing them with *R. cyclas*. As already stated the author is not confident of the

specific identification of these specimens; but on account of the correspondence of certain characters with those of *R. cyclas* they have been referred to that species with a query.[1]

Length of Ernstville specimens, 10-14 mm.; width, 14-20 mm.

Length of Hanging Rock specimens, 7-8 mm.; width, 9-10 mm.

Length of Williams Road specimen, about 9.3 mm.; width about 9.8 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER (?). Hanging Rock, W. Va. HAMILTON MEMBER. Williams Road 3½ miles southeast of Cumberland; Ernstville; Licking Creek east of Warren Point.

Collection.—Maryland Geological Survey.

Genus SCHIZOPHORIA King

SCHIZOPHORIA STRIATULA (Schlotheim) (?)

Plate XIV, Figs. 13, 14

Anomia terebratulites striatulus Schlotheim, 1813, Min. Taschenbuch, viii, pl. i, fig. 6.

Orthis striatula Davidson, 1865, Brit. Devonian Brach., Pal. Soc., p. 87, pl. xvii, figs. 4-7.

Orthis impressa Hall, 1843, Geol. N. Y., pt. iv, p. 267, fig. 2.

Orthis iowensis Hall, 1858, Geol. Surv. Iowa, vol. i, pt. ii, p. 488, pl. ii, fig. 4.

Orthis impressa Hall, 1867, Pal. N. Y., vol. iv, p. 60, pl. viii, figs. 11-19.

Orthis iowensis White, 1880, Second Ann. Rep. Indiana Bureau Statistics and Geol., p. 501, pl. v, figs. 10-12.

Orthis iowensis White, 1881, Tenth Rep. State Geol. Indiana, p. 133, pl. v, figs. 10-12.

Orthis impressa Walcott, 1884, Mon. U. S. Geol. Surv., vol. viii, p. 115, pl. xiii, fig. 13.

Orthis striatula Williams, 1889, Am. Geologist, vol. iii, p. 232.

Schizophoria iowensis Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pp. 212, 226, pl. vi A, fig. 29.

Schizophoria impressa Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, pp. 212, 216, pl. vi, fig. 31; pl. vi A, figs. 26, 27.

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[1] Dr. Kindle's Bulletin on the Onondaga Fauna of the Allegheny Region has appeared since the following description was in type. It then appeared to the writer that perhaps part of these specimens might be referred to *Dalmanella lenticularis* (Vanuxem) and the figured ones were sent to Dr. Kindle, who wrote December 17, 1912, that those from Ernstville and Hanging Rock, W. Va., " represent *D. lenticularis* in my judgment and doubtless came from the beds I have referred to the Onondaga." On the explanation of Plate XIV the names for the specimens from these two localities have been changed to *Dalmanella lenticularis* (Vanuxem). Dr. Kindle also wrote that " The specimen numbered 4940 [from Williams Road] I would identify as you have indicated as *Rhipidomella cyclas* ? Hall."

Schizophoria striatula Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 375.
Schizophoria striatula Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 268, figs. 321d-f.

Description.—A single specimen of a partly exfoliated ventral valve (?) was found, upon which the description is based. Shell considerably wider than long; greatest width near the middle; moderately convex at the sides and flattened toward the umbo; a shallow sinus begins near the beak which broadens and deepens toward the front; surface apparently marked by fine, even striae and the texture is conspicuously punctate.

This specimen was shown Dr. John M. Clarke, who stated that he would call it a *Schizophoria* sp., but would not identify it specifically; although on account of the deep sinus it is to be compared with *S. impressa* Hall. Prof. Schuchert after examining it wrote "I would make it *Schizophoria striatula* Schl. (?)." On account of its similarity to this species, together with the fact that Dr. E. M. Kindle has recently identified it from the Falls of the Ohio and other localities in Indiana, from both the Sellersburg beds and Jeffersonville limestone, which are regarded as representing respectively the Hamilton formation and Onondaga limestone,[1] it is referred to this species with a question, although it was found in the lower part of the Romney formation in Maryland.

Length, 12 mm.; width, 16 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Ernstville.

Collection.—Maryland Geological Survey.

Order TELOTREMATA

Superfamily RHYNCHONELLACEA

Family RHYNCHONELLIDAE

Genus CAMAROTOECHIA Hall and Clarke

CAMAROTOECHIA CONGREGATA (Conrad)

Plate XIV, Figs. 15-17

Atrypa congregata Conrad, 1841, Fifth An. Rep. N. Y. Geol. Surv., p. 55.
Rhynchonella (Stenocisma) congregata Hall, 1867, Pal. N. Y., vol. iv, p. 341, pl. liv, figs. 44-59.
Camarotoechia congregata Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 192, pl. lvii, figs. 15-27.

[1] Ind. Dept. Geol. and Nat. Resources; 25th An. Rept., 1900 (1901), p. 626.

Camarotoechia congregata Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 165.

Camarotoechia congregata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 203.

Description.—Shell robust, varying from short-ovate to subglobose; length and width nearly equal or a little wider than long; front rounded or straight in the middle; sides curved abruptly; apex pointed. Ventral valve with a moderate sinus which often begins at about one-third the length from the apex and becomes conspicuous towards the front; beak, in old shells, closely arcuate over the apex of the opposite valve, in young shells, nearly straight or slightly incurved. Dorsal valve gibbous in old shells, regularly convex in young specimens; mesial fold scarcely conspicuous on the upper half of the shell, sometimes prominent near the margin; in the interior a distinct septum reaching half the length of the valve. Surface, in young shells, marked by nine or ten distinct subangular or rounded plications; in older shells, by eighteen to twenty-two, of which three or four occupy the mesial sinus and four or five the mesial fold; there are also slender concentric striae, which are sometimes a little imbricated near the front margin.

This species occurs in some of the coarse arenaceous shales of Maryland; but it is not common except in occasional thin zones, specimens from which agree fairly well with those of the New York Hamilton. The broader forms of the Maryland specimens agree in form, and in number and strength of plications, fairly well with the New York type specimens. There are others which are more pointed than most of the New York specimens, while the plications are more slender. The species is characterized by its robust form, abrupt curvature of sides, rather moderate fold and sinus with the exception that the latter is well marked toward the front of the shell, three or four plications in the sinus and four or five on the mesial fold.

Length, 12-19 mm.; width, 12-19 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge (?). Western Md.; Williams Road, 3½ miles southeast of Cumberland; on the Hancock-Harrisonville Road about 2 miles north of Hancock; in run at Hancock, east of Catholic church; along Flintstone Creek in Gilpin (?); west of iron bridge over Town Creek northeast of

Oldtown; on Romney-Hanging Rock Road about ½ mile north of Romney, W. Va. (?); B. & O. R. R. cut at Hancock Station, W. Va. (?).

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

CAMAROTOECHIA PROLIFICA Hall

Plate XV, Figs. 1-3

***Rhynchonella* (*Stenocisma*) *prolifica* Hall, 1867, Pal. N. Y., vol. iv, p. 343, pl. liv A, figs. 1-10.**

***Stenoschisma prolifica* Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.**

***Camarotoechia prolifica* Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 192, pl. lvii, figs. 42, 43.**

***Camarotoechia prolifica* Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 168.**

Description.—Shell subtriangular-ovate; length and width about equal; front rounded, with a shallow sinus and gentle elevation, depressed in young shells and becoming gibbous in older ones. Ventral valve depressed-convex in the middle, elevated or a little gibbous on the umbo, curving to the sides and with a shallow sinus below the middle; apex slightly incurved. Dorsal valve equally convex with the ventral, sometimes a little more convex; below the middle of the valve the mesial fold becomes more or less elevated, but rarely rises conspicuously above the general outline; in the interior is a short septum. Surface marked by from about twenty to twenty-four angular plications, of which three occupy the mesial sinus and four the mesial fold.

A partly covered and more or less exfoliated ventral valve from a calcareous layer in West Virginia, opposite Madders Island, four miles south of Cumberland, is referred to this species as well as specimens from other localities. The plications are fully as small and angular as those represented in the figures of New York specimens and rather more numerous than on some of them with which they have been compared; there are three plications in the sinus, and the valve is rather more convex in the middle than in specimens from arenaceous shales. This species is distinguished by its shape, slender angular plications, and shallow sinus with three plications.

Length, 9 mm.; width, 8 mm. of Potomac River specimen.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. B. & O. R. R. cut at 21st Bridge (?). HAMILTON MEMBER. B. &. O. R. R. cut at 21st

Bridge. Williams Road, 3½ miles southeast of Cumberland; on National Road northeast of Cumberland; on road east of Pine Hill about 4 miles north of Oldtown; W. Va. side Potomac River, 4 miles south of Cumberland.

Collections.—Maryland Geological Survey; American Museum of Natural History.

CAMAROTOECHIA SAPPHO Hall

Plate XV, Fig. 4

Rhynchonella sappho Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 87.

Rhynchonella (*Stenocisma*) *sappho* Hall, 1867, Pal. N. Y., vol. iv, p. 340, pl. liv, figs. 33-43.

Camarotoechia sappho Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 192, pl. lvii, figs. 10-14.

Camarotoechia sappho Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 168.

Camarotoechia sappho Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 288, figs. 354c, d.

Description.—Shell large; gibbous, subelliptical; nearly straight in the middle of the front, abruptly pointed at the beak; sides rounded to the mesial fold and sinus. Ventral valve depressed-convex, somewhat gibbous on the umbo; flattened and somewhat depressed in the middle towards the front; sinus becomes well marked about one-third the distance from the apex towards the front; apex abruptly acute, and more or less incurved according to age. Dorsal valve gibbous, regularly arching transversely; the mesial fold becoming conspicuous only towards the front; in young shells only moderately convex. Surface marked by eighteen to twenty-four plications, a smaller number in young specimens, those toward the cardinal margin less elevated; about four to six mark the sinus and fold. In old shells the plications are grooved towards the front, and those of the sides of the dorsal valve are abruptly bent towards the ventral valve. The shell is concentrically marked by fine thread-like elevated striae, which are more conspicuous and strongly undulating towards the front.

An exfoliated ventral valve of this species is among the Johns Hopkins collections from western Maryland, the exact locality of which is unknown. It is rather more triangular in shape than the normal adult forms of this species, and the sinus, which is rather deeper and more sharply defined, contains three conspicuous plications with a less strongly defined fourth

one at one side. This species is distinguished by its shape, size, strong plications, broad sinus and fold towards the front of the shell marked by from four to six plications.

Length of Maryland specimen, 26 mm.; width, 31 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Western Maryland; on the Romney-Hanging Rock Road about ½ mile north of Romney, W. Va.

Collections.—Maryland Geological Survey; American Museum of Natural History.

CAMAROTOECHIA sp.

Plate XV, Fig. 5

Description.—The figured exfoliated ventral valve does not agree closely with figured specimens; but Prof. Schuchert and Dr. J. M. Clarke, both of whom have seen the specimen, agree that it is better not to describe it as a new species. The shell is of medium size; sinus deep and well marked, containing three rather large and prominent plications; sides with three or four plications which are elevated and conspicuous near the margin. In some respects the specimen resembles *Camarotoechia congregata* (Con.); but the lateral plications are stronger and more highly raised at the margin, in this respect something like *Pugnax*. Dr. Clarke also suggested that it be compared with *C. sappho* Hall.

Length, 17 mm.; width, 17 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Flintstone Creek in Gilpin; Williams Road ¼ mile east of Queen City Hotel, Cumberland.

Collection.—Maryland Geological Survey.

Genus LIORHYNCHUS Hall

LIORHYNCHUS LIMITARE (Vanuxem)

Plate XV, Figs. 6-8

Orthis limitaris Vanuxem, 1842, Geol. N. Y., pt. iii, p. 146, fig. 3.
Atrypa limitaris Hall, 1843, Geol. N. Y., pt. iv, p. 182, fig. 11.
Atrypa limitaris Rogers, 1858, Geol. Penna., vol. ii, pt. ii, p. 826, fig. 652.
Leiorhynchus limitaris Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 85.

Leiorhynchus limitaris Hall, 1867, Pal. N. Y., vol. iv, p. 356, pl. lvi, figs. 6-21.
Liorhynchus limitaris Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 194, pl. lix, figs. 1-5.
Leiorhynchus limitare Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 237.
Liorhynchus limitare Clarke, 1903, N. Y. State Mus., Bull. 65, p. 253.
Leiorhynchus limitare Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 289, figs. 357a, b.

Description.—Shell ovate, suborbicular or transverse; moderately or extremely gibbous, except in thin shales, where it is almost flat; sinus and mesial fold more or less developed. Ventral valve in young shells scarcely less convex than the opposite, becoming gradually more dissimilar with growth; in old shells it is rather gibbous near the beak, gradually depressed below, becoming deeply sinuate, produced in front and abruptly truncate. Dorsal valve more convex than ventral, gibbous in old shells, the mesial fold becoming developed below the middle of its length; umbo gibbous and often rising nearly as high as the beak of the ventral valve. Surface marked by numerous angular or subangular plications, those of the mesial fold and sinus distinctly bifurcating, while sometimes a few of those on the sides are divided; concentrically marked by fine striae.

In the fissile black shales, forming the lower part of the Romney formation in Maryland (the best locality noted is the southern end of the B. & O. R. R. cut at 21st Bridge), specimens are common of a nearly flat *Liorhynchus*, the form of which is due to crushing, which are referred to this species. The outline is similar to that of the young specimen of *L. multicosta* = *laura* represented by fig. 26 on pl. lvi, vol. iv, Palæontology of New York; but none of these specimens reach the size of the adult of that species, the plications are somewhat finer, and those of the mesial fold and sinus distinctly bifurcate. While the specimens do not agree in form with those from the calcareous layers of the Marcellus shales, they are similar to the flattened specimen from "thinly laminated shales" represented by fig. 21 of the above-mentioned plate, and also similar in general appearance to specimens of this species which the writer has collected in the thin black shales of the New York Marcellus. The Maryland specimens show no appreciable differences from flattened speci-

mens in the office of the New York State Paleontologist labeled *Liorhynchus limitare* from the fissile Marcellus shales of Western New York. The size, form, strength of plications and concentric striae are about identical. Specimens were submitted to Prof. Charles Schuchert, who wrote as follows: "It is very difficult to be certain of these crushed specimens, but they are usually called *L. limitare* when from the Marcellus, and these are." There is not a very marked difference between young specimens of *L. laura* and *L. limitare*, but the smaller size and finer plications of these specimens refer them to the latter species. It is also to be noted that these specimens in size, shape and strength of plications are similar to *L. dubium* Hall of the Marcellus shale.

Length, 8-13 mm.; width, 8-14 mm.

Occurrence.—ROMNEY FORMATION, MARCELLUS MEMBER. B. & O. R. R. cut at 21st Bridge; W. Va. Cent. R. R. cut at 21st Bridge; Williams Road, 3½ miles southeast of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum.

LIORHYNCHUS LAURA (Billings)

Plate XV, Figs. 9-12

Rhynchonella (?) *laura* Billings, May, 1860, Canadian Jour., vol. v, p. 273, figs. 26-28.

Leiorhynchus multicosta Hall, December, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 85, figs. 14, 15 on p. 94.

Leiorhynchus multicosta Hall, 1867, Pal. N. Y., vol. iv, p. 358, pl. lvi, figs. 26-40.

Liorhynchus multicosta and *laura* Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 194, pl. lix, figs. 8-10, 13-17.

Leiorhynchus laura Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 237.

Leiorhynchus laura Shimer and Grabau, 1902, Bull. Geol. Soc. Amer., vol. 13, pp. 168-170.

Liorhynchus multicostum Clarke, 1903, N. Y. State Mus., Bull. 65, p. 253.

Leiorhynchus laura Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 289, fig. 357c.

Description.—Shell ovate, with the length and greatest width nearly equal, in compressed specimens the width is often greater than the length. Ventral valve gibbous on the umbo, curving to the sides, becoming gradually depressed in the center and forming a sinus which is broad and

gently defined below the middle of the shell. Dorsal valve much more convex than the ventral, the greatest gibbosity a little above the middle, the center elevated in a broad mesial fold. Surface marked by numerous rounded or subangular plications, of which from three to seven are depressed in the sinus and a corresponding number elevated on the fold, the plications of the fold and sinus bifurcate, while those of the sides are simple or obscurely bifurcating, and all usually become obsolete at one-third to one-fourth the length of the shell from the apex; concentrically marked by raised thread-like striae.

In the arenaceous shales of the Romney formation and above the fissile black shales, are specimens of *Liorhynchus* which are not much larger than those from the black shales, but are marked by somewhat coarser plications. These specimens are never abundant and they have been referred to *L. laura,* although most of them are smaller than the figured specimens of that species.

Length, 8-13 mm.; width, 9-13 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road, 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; New York State Museum.

LIORHYNCHUS cf. MYSIA

Plate XV, Figs. 13-17

Leiorhynchus mysia **Hall, 1867, Pal. N. Y., vol. iv, p. 357, pl. lvi, figs. 1-5.**

Description.—"Shell small, suboricular; valves subequally convex, with a few strong plications reaching half way from the margin to the beak of the shell. This species is distinguished by its small size, circular form, and proportionally much stronger plications, of which there are at least three on each side of the fold and sinus, terminating near the middle of the shell. In a few larger individuals, the plications near the middle of the shell have a greater extent. A single plication marks the sinus. The length of the shell is usually less than three-eighths of an inch; width a little greater. One individual measures nearly a quarter of an inch in

length. In a specimen of *L. limitaris* of the same size, the plications are scarcely perceptible." Hall, 1867.

Occurrence.—ROMNEY FORMATION, MARCELLUS MEMBER. Williams Road, 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

CENTRONELLA cf. OVATA Hall

Plate XVI, Figs. 1-3

Centronella ovata **Hall, 1867, Pal. N. Y., vol. iv, p. 419, pl. lxi A, figs. 47-49.**

Description.—Shell small, oval or slightly ovate; width and height as four to five, greatest width near the middle of the length. Dorsal valve depressed convex, without perceptible sinus. Ventral valve much deeper than the dorsal, subcarinate along the center, most ventricose just below the beak, which is strongly incurved; lateral margins of the beak slightly carinate. Surface marked only by concentric lines of growth. This species resembles *C. julia* in form, but is a narrower shell, with a less convex dorsal valve; the ventral valve is more ventricose and carinate along the middle, and the beak more strongly incurved. Hall, 1867.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. One mile east of Oldtown, in cut of Western Maryland Railroad.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Superfamily TEREBRATULACEA

Family TEREBRATULIDAE

Subfamily TEREBRATULINAE

Genus EUNELLA Hall and Clarke

EUNELLA LINCKLAENI Hall

Plate XV, Figs. 18-23

Terebratula lincklaeni **Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 88.**

Cryptonella lincklaeni **Hall, 1861, Fourteenth Rep. N. Y. State Cab. Nat. Hist., p. 101.**

Cryptonella (?) *lincklaeni* Hall, 1867, Pal. N. Y., vol. iv, p. 397, pl. lx, figs. 49-65.

Terebratula lincklaeni Hall, 1867, Pal. N. Y., vol. iv, Corrigenda.

Eunella lincklaeni Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 290, pl. lxxx, figs. 28-32.

Eunella lincklaeni Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 223.

Eunella lincklaeni Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 303, fig. 378.

Description.—Shell ovate or subelliptical, usually broader below the middle, varying from moderately convex to gibbous and sometimes subcylindrical; front rounded, subtruncate, or a little depressed. Ventral valve sometimes a little flattened towards the front or marked by a narrow mesial depression; beak more or less abruptly incurved and truncate by a foramen of moderate size. Dorsal valve with the greatest convexity about the middle of the length, and thence curving regularly to the sides and base. Surface marked by fine concentric striae of growth, which are sometimes crowded together towards the front, causing a thickening of the shell; shell-structure distinctly punctate.

The Maryland specimens are all in the condition of rather poorly preserved internal or external impressions which were found in arenaceous shales. Although crushed and more or less imperfectly preserved the specimens agree fairly well with figures 64 and 65 of pl. lx, vol. iv, Palæontology of New York, which represent dorsal and ventral internal impressions of this species, showing in a similar manner the cavities left by the dental and hinge plates and apparently the diverging muscular or vascular lines. One internal impression when magnified shows a rather regular pustulose surface as represented in fig. 22, pl. xv, the pustules being casts of the punctae of the shell structure. Dr. E. R. Cumings of Indiana University examined this specimen with great care under enlargements from 5 to 85 diameters and found this delineation to be correct. He also examined very perfectly preserved shells in the Yale University Museum and stated that he got "precisely similar appearance with similar preservation." He also reported that "the outer surface of the shell in *Eunella* appears minutely pustulose, owing to the elevation of the mouth of the punctae."

Length, 19 mm.; width, 13 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. West of iron bridge over Town Creek northeast of Oldtown; on road east of Pine Hill about 4 miles north of Oldtown.

Collections.—Maryland Geological Survey; American Museum of Natural History.

Family TEREBRATELLIDAE

Subfamily TROPIDOLEPTIINAE

Genus TROPIDOLEPTUS Hall

TROPIDOLEPTUS CARINATUS (Conrad)

Plate XVI, Figs. 7-14

Strophomena carinata Conrad, 1839, Third Ann. Rep. N. Y. Geol. Survey, p. 64.

Tropidoleptus carinatus Hall, 1857, Tenth Rep., N. Y. State Cab. Nat. Hist., p. 151, figs. 1, 2.

Tropidoleptus carinatus Rogers, 1858, Geol. Penna., vol. ii, pt. ii, p. 828, fig. 672.

Tropidoleptus carinatus Hall, 1867, Pal. N. Y., p. 407, pl. lxii, figs. *2a-2c*, *3a-3p*, *3r-3u*, *3w*, *3x*.

Tropidoleptus carinatus Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.

Tropidoleptus carinatus Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 304, figs. 227, 228, pl. lxxxii, figs. 26-36.

Tropidoleptus carinatus Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, p. 457.

Tropidoleptus carinatus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 344.

Tropidoleptus carinatus Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 305, fig. 382.

Description.—Shell concavo-convex; outline generally semielliptical, but the lateral margins are sometimes nearly straight and the front broadly rounded; hinge-line equaling, greater or less than the width of the shell, so that the cardinal extremities vary from rounded to mucronate. Ventral valve convex; broadly subcarinate along the middle, due to the greater width and prominence of the central plication, and sloping to the lateral margins and front. Cardinal extremities deflected; average width of cardinal area about 1 mm., the outer margin sloping toward the extremities, the area striated longitudinally and divided by a broad, open delthyrium. Dorsal valve varying from strongly concave to nearly flat,

in part of the specimens with a median depression below the middle of the valve. There is a narrow cardinal area interrupted in the middle by a wide, convex chilidium. In the interior of this valve a median septum extends from the anterior part of the cardinal process to the anterior third of the shell. Surface marked by about eighteen to twenty broad, simple, rounded plications which are generally wider than the interspaces. There are fine, undulating, concentric striae, and a few stronger imbricating lamellae mark the stages of growth of the shell.

The specimens from Maryland show about all the forms of this species which are represented in the Palæontology of New York (see vol. iv, pl. lxii), as from the arenaceous,ferruginous shales east of Hancock are specimens similar to figures *3c* and *3e*, while the bluish, slightly calcareous shales at 21st Bridge contain very large forms, even larger than figure *3l* of the N. Y. Palæontology, which are likewise characterized by coarse plications that become inconspicuous on the thickened margin of the shell. The figures of the Maryland specimens show one of normal size and another of the large form. Not infrequently the shell substance is well preserved and the punctate structure beautifully shown.

Length of average adult, 20 mm.; width, 25 mm.; length of large specimen, 28 mm.; width, 38 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge. Williams Road, 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill; Williams Road, ¾ mile east of Queen City Hotel, Cumberland; Williams Road, ¼ mile east of Queen City Hotel, Cumberland; Town Creek Road at George Diefenbaugh's; B. & O. R. R. cut at 21st Bridge; on National Road, ½ mile west of Tonoloway Ridge; on Oldtown Road east of Maryland Ave., Cumberland; McCoys Ferry; southwest of McCoys Ferry; on the Hancock-Harrisonville Road about 2 miles north of Hancock; in run at Hancock east of Catholic church; along Flintstone Creek in Gilpin; on National Road in Gilpin; west of iron bridge over Town Creek northeast of Oldtown; on National Road ½ mile west of Licking Creek; on road east of Pine Hill about 4 miles north of Oldtown; B. & O. R. R. cut at Hancock Station, W. Va.; on road about half way between Romney and

Hanging Rock, W. Va.; on the Romney-Hanging Rock Road about ½ mile north of Romney, W. Va.

Collections.—Maryland Geological Survey; New York State Museum.

Superfamily SPIRIFERACEA

Family ATRYPIDAE

Genus ATRYPA Dalman

ATRYPA RETICULARIS (Linné)

Plate XVI, Figs. 4-6

Anomia reticularis **Linné, 1767, Systema Naturae, ed. xii, vol. i, p. 1132.**
Atrypa chemungensis **Conrad, 1842, Jour. Acad. Nat. Sci. Phila., vol. viii, p. 265.**
Atrypa chemungensis **Vanuxem, 1842, Geol. N. Y., pt. iii, p. 182, fig. 4.**
Terebratula reticularis **Hall, 1849, Am. Jour. Sci., 2d ser., vol. xx, p. 227.**
Atrypa reticularis **Hall, 1852, Pal. N. Y., vol. ii, p. 72, pl. xxiii, fig. 8; p. 270, pl. lv, fig. 5.**
Atrypa reticularis **Hall, 1859, Pal. N. Y., vol. iii, p. 253, pl. xlii, fig. 1.**
Atrypa reticularis **Hall, 1867, Pal. N. Y., vol. iv, p. 316, pl. lii, figs. 1-3, 7-12; pl. liii, figs. 3-19; pl. liii A, figs. 22, 23.**
Atrypa reticularis **Nicholson, 1874, Rep. Pal. Ontario, p. 79.**
Atrypa reticularis **Nettelroth, 1889, Kentucky Fossil Shells, p. 91, pl. xiv, figs. 12-23; pl. xv, fig. 1.**
Atrypa reticularis **Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 165, fig. 153; pl. lv, figs. 1-17.**
Atrypa reticularis **Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 154.**
Atrypa reticularis **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 195.**
Atrypa reticularis **Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 310, figs. 389a, 389b, 392a-c.**

Description.—Shell large but variable in form and dimensions; usually oblong-ovate, with the greatest width a little below the hinge-line. Ventral valve usually moderately convex near the umbo, flattened toward the sides, and markedly depressed in front, with occasionally a broad but shallow sinus towards the front margin; beak small, incurved, and perforated by a small foramen. Dorsal valve convex, always more so than the ventral, and frequently very gibbous; greatest convexity near the middle, from which it slopes abruptly to the lateral margins; generally without a mesial fold corresponding to the sinus of the ventral valve. Surface marked by clear rounded or sub-angular plications, which in-

crease toward the margins by bifurcation and intercalation, and are crossed by concentric lines of growth giving a reticulated appearance to the shell. The muscular areas are conspicuous, outside of which the surface is papillose, vascular markings are sometimes visible near the margin and in the dorsal valve there is a septum in the upper part of the muscular area. (For description see Nicholson 1874, and Nettelroth 1889.)

As is generally the case with the Maryland material most of the specimens are impressions, but a few preserve the shell. The latter have been compared with typical specimens of this species and *A. spinosa* Hall from the Hamilton shales of New York and they clearly belong to *A. reticularis* rather than to *A. spinosa*. The plications on a part of the Maryland specimens are somewhat coarser than on those from New York, but are not as coarse as the costae of *A. spinosa* and do not show at all the nodose or strongly reticulated surface of that species. Specimens were shown Dr. J. M. Clarke, who regards them as Hamilton representatives of *A. reticularis,* clearly distinct from *A. spinosa*. There is a marked and constant difference in large numbers of specimens representing these two species from Eighteen Mile Creek in western New York and apparently only *A. reticularis* is represented in the Maryland Collection. This seems odd because *Atrypa spinosa* is the species which has been reported from Maryland and Virginia. A figure of this species is given by Rogers from the Hamilton of Pennsylvania;[1] while Hall stated that "In collections from the Hamilton group near Cumberland (Md.) and the adjacent parts of Virginia, there are many casts and exfoliated shells of *A. spinosa,* but none of them with the finer costae, or that can be referred to *A. reticularis*."[2] And in another place it is stated that "In casts of this species [*A. spinosa*] from the Hamilton group of Maryland and Virginia, we find the same characteristic features preserved as above described [under the specific description of this species]."[3] This identification of Hall apparently has been followed by later observers, for

[1] Geol. Penna., 1858, vol. ii, pt. ii, p. 828, fig. 671.
[2] Pal. N. Y., vol. iv, 1867, p. 324.
[3] *Ibid.*, p. 323.

Keyes reported *Atrypa spinosa* from the Hamilton of western Maryland[1] and Prof. Schuchert listed it as from Maryland and Virginia.[2] It is not intended to state that *A. spinosa* does not occur in this region; but according to the writer's observations and the collections of the State Survey the common species is *A. reticularis*. This species is distinguished by its large size, shape, great convexity of dorsal and slight convexity of ventral valve, closely incurved ventral beak, rounded bifurcating plications crossed by concentric striae and lines of growth. In *A. spinosa* the valves are more nearly equally convex, the radiating plications are much coarser, and fewer, and are crossed by very conspicuous concentric lamellae which give a highly reticulated and nodose appearance to the surface of the shell.

Length, 18-42 mm.; width, 20-35 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; on National Road northeast of Cumberland; along Flintstone Creek in Gilpin.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Family SPIRIFERIDAE

Genus CYRTINA Davidson

CYRTINA HAMILTONENSIS Hall

Plate XVII, Figs. 1-9

Cyrtia hamiltonensis Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 166.

Cyrtina hamiltonensis Hall, 1867, Pal. N. Y., vol. iv, p. 268, pl. xxvii, figs. 1-4; pl. xliv, figs. 26-33, 38-52.

Cyrtina hamiltonensis Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.

Cyrtina hamiltonensis Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 46, pl. xxviii, figs. 23-33, 43, 45, 46, 53.

Cyrtina hamiltonensis Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 198.

Cyrtina hamiltonensis Clarke, 1903, N. Y. State Mus., Bull. 65, p. 224.

Cyrtina hamiltonensis Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 313, figs. 393a-c.

Description.—Shell small and spirifer-like; hinge-line equal to the greatest width of the shell; proportions of length, breadth and height

[1] Johns Hopkins Univ. Circ., vol. xi, 1891, p. 29.

[2] Bull. U. S. Geol. Surv., No. 87, p. 156.

variable. Ventral valve obliquely subpyramidal; beak very prominent, straight or incurved, frequently distorted or turned to one side; mesial sinus wide and sharply defined with rounded or subangular bottom; cardinal area high, triangular, generally arcuate with angular margins; delthyrium narrow, covered by an elongate, convex pseudo-deltidium which is perforated below the apex by an elongate foramen; the internal impressions show a slit in the bottom of the sinus extending from the beak toward the front of the valve for one-half or more of its length which represents a longitudinal median septum. Dorsal valve slightly convex; broad, prominent mesial fold with sometimes a slight groove along its center which is bounded by broader furrows than those between the plications; beak scarcely rising above the hinge-line; cardinal area narrow and linear. Surface marked by six to eight simple, rounded plications on each side of the fold and sinus, crossed by fine concentric lines of growth which are infrequently shown on the impressions of the Maryland specimens; surface minutely granulose or papillose; shell structure distinctly punctate.

This species is not abundant in Maryland and not as common in occurrence as in the Hamilton formation of New York. The Maryland specimens are mainly impressions found in the rather arenaceous shales or thin bedded sandstones of the Romney formation; but in this condition they agree very closely with specimens from similar lithologic deposits of the New York Hamilton. This species is readily distinguished by the very convex ventral valve with high generally arcuate cardinal area; slightly convex dorsal valve; small number of plications; granulose surface marking and punctate shell structure.

Length, 7-10 mm.; width, 10-15 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER (?). Hanging Rock, W. Va. HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; on Oldtown Road east of Maryland Ave., Cumberland; on the Hancock-Harrisonville Road about 2 miles north of Hancock; McCoys Ferry; on National Road northeast of Cumberland; in run at Hancock east of Catholic church; ¼ mile north of Green Spring Furnace; west of iron bridge over Town Creek northeast of Oldtown; on road east of Pine

Hill about 4 miles north of Oldtown; B. & O. R. R. cut at Hancock Station, W. Va.; on road about half way between Romney and Hanging Rock, W. Va.; on the Romney-Hanging Rock Road about ½ mile north of Romney, W. Va.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Genus SPIRIFER Sowerby

SPIRIFER MUCRONATUS (Conrad)

Plate XVII, Figs. 10-18

Probably *Terebratula pennata* Atwater, 1820, Amer. Jour. Sci. Arts, vol. ii, p. 244, pl. i, figs. 2, 3.

Delthyris mucronata Conrad, 1841, Fifth Ann. Rep. Geol. Surv. N. Y., p. 54.

Spirifer mucronata Billings, 1856, Canadian Nat. Geol., vol. i, p. 474, pl. vii, figs. 9, 10.

Spirifer mucronata Rogers, 1858, Geol. Penna., vol. ii, pt. ii, p. 828, fig. 668.

Spirifera mucronata Billings, 1861, Canadian Jour., n. ser., vol. vi, p. 254, figs. 59-62.

Spirifera mucronata Hall, 1867, Pal. N. Y., vol. iv, p. 216, pl. xxxiv, figs. 1-32.

Spirifera pennata Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.

Spirifer mucronatus Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, pp. 14, 17, 36, pl. xxix, fig. 8, pl. xxxiv, figs. 13-22.

Spirifer pennatus Schuchert, Bull. U. S. Geol. Surv., No. 87, p. 401.

Spirifer mucronatus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 321.

Spirifer mucronatus Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 330, fig. 421.

Spirifer mucronatus Cleland, 1911, Fossils and Stratigraphy Mèd. Devonic Wisconsin, p. 80.

Description.—Shell medium size; more or less gibbous; cardinal areas low, and cardinal angles sometimes truncate but usually extended and often prolonged into mucronate points which give the hinge-line a length of two to five times that of the shell. Ventral valve often scarcely more convex than the dorsal; beak small and incurved over the narrow cardinal area which is longitudinally striated; mesial sinus is sharply defined quite to the apex and limited by angular plications which are stronger than the adjacent ones. The sinus is generally shallow and rounded in the bottom, but sometimes flat or with a small fold in the center. In the interior is a small striated muscular area. Dorsal valve moderately con-

vex; mesial fold prominent, flat or rounded above and frequently marked by a median groove. Beak incurved; cardinal area extremely narrow, about one-third as high as that of the ventral valve. Surface marked by from eight to fifteen or more subangular plications on either side of the mesial sinus or fold, the outer ones of which do not reach the beak. On well preserved specimens the plications are crossed by numerous fine lamellose striae which become crowded and closely imbricating towards the front of the shell, sometimes marking several lines of interrupted growth.

At some localities in Maryland this species is very abundant forming a considerable part of the rock. As illustrations may be cited the locality about two miles north of Hancock on the road from that town to Harrisonville, Pa.; one near the bridge over Town Creek three miles northeast of Oldtown; while on Evitts Creek below Wolfe Mill are specimens with the shell beautifully preserved. Among the Maryland specimens may be found examples of most of the forms figured in Palæontology of N. Y. (see vol. iv, pl. xxxiv). Figures 10 and 11 of this report represent a specimen from Evitts Creek with truncate cardinal angles similar to the narrow form shown by figure 8 in the Palæontology of New York; while at McCoys Ferry an extremely mucronate specimen was obtained with a length of 15 mm., and a width of 35 mm. for one-half of the shell along the hinge-line, of which the mucronate point was fully 20 mm. in length. The great majority of the specimens are exfoliated and furnish only internal impressions.

Length of nonmucronate specimen, 15 mm.; width, 26 mm.; length of nonmucronate triangular shaped specimen, 22 mm.; width, 45 mm.; length of average specimen, 16 mm.; width, 39 mm.; length of mucronate specimen but not extreme, 15 mm.; width, 60 mm.; length of another specimen, 18 mm.; width, 50 mm.

In reference to the synonymy of this species Miller and Schuchert consider *Delthyris mucronata* Con. as a synonym of *Terebratula pennata* Atwater; while Dr. J. M. Clarke states that "I see no good reason for calling *Spirifer mucronatus* Conrad *S. pennatus* Atwater. It may be true that the latter is what we mean by *S. mucronatus* but it would be difficult

to demonstrate it as no one knows where or what the original specimen is. It seems to me wiser and safer to retain Conrad's name as we know definitely what Conrad was talking about."[1] Atwater's figures are crude and from them the writer would hardly feel warranted in accepting the identity of the two forms. Prof. Schuchert's observation, however, is that "Atwater's specimen was found in the drift of Ohio. Mr. Miller is correct in regarding it the same as the well-known *S. mucronatus*."[2] Atwater's home was in Circleville, Pickaway County, in southern central Ohio, and it is apparently generally considered that the specimen was found in that vicinity. Much of Pickaway County is deeply covered by drift and known as the Pickaway plains, the greater part of which is underlain by the Ohio shale, which is the case geologically at Circleville. Atwater states that the specimen "is a light drab-colored limestone,"[3] but did not state whether it was loose or obtained from solid rock. Miller in calling attention to the synonymy of the species stated that "Circleville is not far distant from exposures of the Hamilton group";[4] still the distance to rocks containing typical specimens of *Spirifer mucronatus* is probably considerably greater than he supposed. In Deep Cut north of Prout's Station, about six miles south of Sandusky, at the locality given by Newberry.[5] The writer collected typical specimens of this species from the light gray calcareous shale of Hamilton age which occurs in the ditch below the base of the black Huron shale. Again, in the drift overlying the Richmond formation on the bank of Morris Hill Run about four miles south of Waynesville, in southwestern Ohio, a very characteristic specimen of this species was obtained. This locality is south of west of Circleville and, therefore, it is shown that specimens of this species have been carried in the drift farther to the south than Circleville.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge (?). Williams Road, 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill; Williams

[1] Letter from Dr. J. M. Clarke, April 20, 1901.
[2] Bull. U. S. Geol. Surv., No. 87, p. 401.
[3] *Loc. cit.*, p. 245.
[4] Proc. Davenport Acad. Nat. Science, vol. ii, p. 220.
[5] Rept. Geol. Surv. Ohio, vol. ii, pt. 1, 1874, p. 190.

Road ¾ mile east of Queen City Hotel, Cumberland; Williams Road, ¼ mile east of Queen City Hotel, Cumberland; in Jennings Run, ½ mile west of Corriganville; Town Creek Road at Geo. Diefenbaugh's; east side Warrior Mt. east of Rush; on National Road ½ mile west of Tonoloway Ridge; B. & O. R. R. cut at 21st Bridge; on Oldtown Road, east of Maryland Ave., Cumberland; McCoys Ferry; southwest of McCoys Ferry; on the Hancock-Harrisonville Road about 2 miles north of Hancock; on National Road northeast of Cumberland; in run at Hancock east of Catholic church; along Flintstone Creek in Gilpin; on National Road in Gilpin; on road east of Pine Hill about 4 miles north of Oldtown; west of Lock No. 56 at Great Cacapon; west of iron bridge over Town Creek northeast of Oldtown; on National Road, ½ mile west of Licking Creek; on the Romney-Hanging Rock Road about ½ mile north of Romney, W. Va.; on road about half way between Romney and Hanging Rock, W. Va.; W. Va. side Potomac River, about 3 and again about 4 miles south of Cumberland; B. & O. R. R. cut at Hancock Station, W. Va.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

SPIRIFER GRANULOSUS (Conrad)

Plate XVIII, Figs. 1-6

Delthyris granulosa Conrad, 1839, Third Ann. Rep. Geol. Surv. N. Y., p. 65.
Delthyris granulifera Hall, 1843, Geol. N. Y., pt. iv, p. 206, fig. 1.
Spirifer granulifera Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 163.
Delthyris congesta Rogers, 1858, Geol. Penna., vol. ii, pt. ii, p. 828, figs. 670, 673.
Spirifera granulifera Hall, 1867, Pal. N. Y., vol. iv, p. 223, pl. xxxvi, figs. 1-13.
Spirifera granulifera Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Spirifer granulosus Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, pp. 29, 30, 31, 39; pl. xxiii, figs. 1-15; pl. xxix, figs. 9-12.
Spirifer granulosus Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 391.
Spirifer granulosus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 317.
Spirifer granulosus Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 328, fig. 417.

Description.—Shell large, ventricose to gibbous; hinge-line generally equal to the greatest width of the shell; cardinal extremities obtuse,

sometimes rounded. Ventral valve most prominent near the umbo, gradually sloping to the cardinal angles; beak incurved; cardinal area moderately high, vertically striated, and divided by a rather large, triangular delthyrium; mesial sinus distinct, subangular in upper part and broad deeply rounded depression in front, often with a slight groove along the center and sometimes with a faintly marked plication on each side. Interior of valve shows broad striated muscular impression, the upper part bounded by strong dental plates. Dorsal valve generally the most ventricose with the greatest convexity at about the middle; mesial fold prominent and rounded with medial rounded depression. Surface marked by from eighteen to twenty-two simple, low, rounded plications on each side of fold and sinus; entire surface of shell in excellently preserved specimens covered by very fine interrupted longitudinal striae which form numerous small pustules or granules, the latter are usually shown on fairly well preserved surfaces; concentric lines of growth and striae are often conspicuous toward the front of the shell.

The Maryland specimens show the variations of this species as found in New York specimens. It is never as abundant in Maryland as *Spirifer mucronatus* (Conrad), although a common species at certain localities, as on Evitts Creek below Wolfe Mill. The species is readily distinguished on account of its large size, form, broad plications, and strongly granulose surface.

Length of average specimen, 48 mm., width, 57 mm.; internal cast length, 38 mm., width, 57 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; in Jennings Run ½ mile west of Corriganville; Town Creek Road at George Diefenbaugh's; B. & O. R. R. cut at 21st Bridge; on Oldtown Road east of Maryland Ave., Cumberland; on the Hancock-Harrisonville Road about 2 miles north of Hancock; McCoys Ferry; on National Road northeast of Cumberland; along Flintstone Creek in Gilpin; west of iron bridge over Town Creek northeast of Oldtown; on National Road ½ mile west of Licking Creek; on road east of Pine Hill about 4 miles north of Oldtown; B. & O. R. R.

cut at Hancock Station, W. Va.; on the Romney-Hanging Rock Road about ½ mile north of Romney, W. Va.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

SPIRIFER AUDACULUS (Conrad)

Plate XVIII, Figs. 7-9

Delthyris audacula Conrad, 1842, Jour. Acad. Nat. Sci. Phila., vol. viii, p. 262.
Delthyris medialis Hall, 1843, Geol. N. Y., pt. iv, p. 208, fig. 8.
Spirifer medialis Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 157.
Delthyris medialis Rogers, 1858, Geol. Penna., vol. ii, pt. ii, p. 828, fig. 669.
Spirifera medialis Hall, 1867, Pal. N. Y., vol. iv, p. 227, pl. xxxviii, figs. 1-25.
Spirifera audacula Whitfield, 1882, Geol. Wisconsin, vol. iv, p. 329, pl. xxv, figs. 25, 26.
Spirifera medialis Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Spirifer audaculus Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, pp. 29-31, 39, pl. xxiv, figs. 1-13; pl. xxix, fig. 5.
Spirifer audaculus Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 382.
Spirifer audaculus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 309.
Spirifer audaculus Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 329, fig. 420a.

Description.—Shell medium size; valves moderately convex in young specimens, becoming ventricose in old shells; hinge-line generally extended beyond the width of the shell below. Ventral valve usually more convex than the dorsal; incurved beak; cardinal area commonly of more than medium height; longitudinally striated and divided in the middle by the delthyrium which is about twice as high as wide; mesial sinus well defined, extending to the apex, of moderate width, rather deep and generally rounded at the bottom. Dorsal valve moderately convex; beak small and slightly incurved; cardinal area linear; mesial fold prominent, rising abruptly at the sides and rounded or slightly flattened on top; cardinal angles slightly reflected. Surface marked by twenty or more simple plications on each side of the fold and sinus and the principal ones, especially of the ventral valve, are often marked along the center by a threadlike groove; toward the front are numerous, often imbricating, concentric lines.

In Maryland this species occurs less frequently than either *Spirifer mucronatus* or *S. granulosus* and most of the specimens are internal impressions. For this reason it is not always easy to separate *S. audaculus* from *S. granulosus;* however, the size, shape and narrower plications of the former generally distinguish the species. Hall's description of the species states that the surface is "marked by from twenty to thirty simple plications on each side of the mesial fold and sinus" while the Maryland specimens rarely show twenty clearly marked plications. An examination, however, of the New York type specimens indicates that part of them scarcely show more than eighteen sharply defined plications. In general *S. audaculus* is readily distinguished from *S. mucronatus* by its larger size, much greater convexity, high ventral cardinal area, and absence of extended hinge-line; from *S. granulosus* by its smaller size, narrower plications, and absence of granulose surface.

Length, 25-35 mm.; width, 35-45 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road, 3½ miles southeast of Cumberland (?); Williams Road, ¼ mile east of Queen City Hotel, Cumberland; east bank Evitts Creek below Wolfe Mill; on Hancock-Harrisonville Road about 2 miles north of Hancock; McCoys Ferry; on National Road, ½ mile west of Licking Creek; east side Warrior Mt. east of Rush; B. & O. R. R. cut at Hancock Station, W. Va. (?).

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

SPIRIFER ACUMINATUS (Conrad)

Plate XVIII, Fig. 10

Delthyris acuminata Conrad, 1839, Third Ann. Rep. N. Y. Geol. Surv., p. 65.
Spirifer acuminata Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 135.
Spirifera acuminata Hall, 1867, Pal. N. Y., vol. iv, pp. 198, 234, pl. xxix, figs. 9-18; pl. xxxv, fig. 24.
Spirifera acuminata Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Spirifer acuminatus Hall and Clarke, 1893, vol. vii, pt. ii, pp. 31, 39, pl. xxxix, figs. 39-42.
Spirifer acuminatus Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 380.

Spirifer acuminatus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 308.
Spirifer acuminatus Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 326, fig. 414.

Description.—Shell large, ventricose; hinge-line usually less than the width of the shell; cardinal extremities rounded or truncate. Ventral not so convex as dorsal valve; wide mesial sinus which is well defined in the upper part, becomes wider, deeper and less distinctly defined in the middle of the shell and is greatly produced in front. Dorsal valve gibbous, highly elevated in the middle into a sharply angular mesial fold and curving from the sides of the fold to the margins of the shell, except at the cardinal angles, where it is a little flattened. Surface marked by from sixteen to twenty plications on each side of the fold and sinus, three or four of which nearest the center are deeply grooved to dichotomous from below the middle of their length; the first ten or twelve plications on each side of the center cover the greater part of the valve.

This species is rare in Maryland and in the Johns Hopkins Collection is represented by a single broken internal impression of the dorsal valve. There is, however, apparently no doubt regarding its identity for the sharp angular fold and central dichotomous plications are well shown. Hall mentioned an impression of this species in the Museum of Marietta College, Ohio, which he stated "from its character, has been derived from the southwestern extension of the Hamilton group, perhaps in Virginia";[1] and Keyes listed it in his paper on the "Paleozoic fossils of Maryland."[2] This species is easily distinguished from the other Spirifers by the high, sharply angular mesial fold and deep sinus, with the few dichotomous plications on each side.

Length, 30 mm.; width, 36 mm., and a comparison of figures indicates that the proportions are about as five to six.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

[1] Pal. N. Y., vol. iv, p. 202.
[2] Johns Hopkins Univ. Circ., vol. xi, p. 29.

SPIRIFER TULLIUS Hall

Plate XIX, Figs. 1-7

Spirifera tullia Hall, 1867, Pal. N. Y., vol. iv, p. 218, pl. 35, figs. 1-9.
Spirifer tullius Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, pp. 14, 35, pl. xxii, fig. 18; pl. xxxvii, figs. 6, 7.
Spirifer tullius Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 408.
Spirifer tullius Clarke, 1903, N. Y. State Mus., Bull. 65, p. 326.
Spirifer tullius Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 332, fig. 422e.

Description.—Shell small, subelliptical, gibbous; hinge-line equal or greater than the width of the shell. Ventral valve gibbous, greatest convexity above the middle of the shell, curving abruptly to the sides and a little flattened at the cardinal angles, mesial sinus sharply defined quite to the beak, not deep, rounded in the bottom; high cardinal area. Dorsal valve moderately convex; mesial fold well defined, wide below and narrow above, flattened and sometimes depressed on the summit; shell curving gently to the lateral margins with slightly flattened cardinal angles. Surface marked by fourteen or more simple, low, flattened or rounded plications on each side of the fold and sinus, which in exfoliated specimens are frequently subangular; the entire surface marked by fine continuous radiating striae, which are most clearly shown on the intervals between the plications and on the fold and sinus.

This species resembles somewhat young specimens of *Spirifer audaculus;* but is distinguished by its more gibbous form, more nearly parallel lateral margins, broader plications and especially by its conspicuous radiating striae. Hall reported this species only from central New York; but since then its occurrence has been noted in Erie County, New York, by Professor Grabau,[1] in eastern central and eastern New York by the writer,[2] while Professor Whiteaves has reported a variety of the species from the Athabasca River in British America.[3]

[1] Bull. Buffalo Soc. Nat. Hist., 1899, vol. vi, p. 208.

[2] 15th An. Rep. State Geol. N. Y., 1895, p. 129; 17th _ibid._, 1899, p. 202; Bull. U. S. Geol. Surv., No. 120, 1894, p. 41.

[3] Cont. Canadian Pal., vol. i, pt. iii, 1891, p. 224.

The Maryland specimens have about twelve clearly defined plications which is found on comparison to be the number on some of the type specimens from New York. Dr. John M. Clarke examined specimens from the Maryland Romney and stated that they were probably *Spirifer tullius.*

Length, 14 mm.; width, 20 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Run at Hancock east of Catholic church; on Hancock-Harrisonville Road about 2 miles north of Hancock; along Flintstone Creek in Gilpin; B. & O. R. R. cut at Hancock Station, W. Va.

Collections.—Maryland Geological Survey; New York State Museum.

SPIRIFER ANGUSTUS Hall

Plate XIX, Figs. 8, 9

Spirifer angusta Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 164, fig. in text.
Spirifera angusta Hall, 1867, Pal. N. Y., vol. iv, p. 230, pl. xxxviii A, figs. 23-32.
Spirifera angusta Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Spirifer angustus Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, pp. 31, 39, pl. xxiv, figs. 14-17.
Spirifer angustus Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 381.
Spirifer angustus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 308.
Spirifer angustus Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 330, fig. 420b.

Description.—Shell with depressed pyramidal outline; great lateral extension with attenuate and acuminate cardinal angles; valves very unequally convex with finely plicate surface. Ventral valve proportionally very deep, forming nearly the entire thickness of the shell; cardinal area extremely elevated and inclined forward, the height nearly equal to the length of the valve; delthyrium about twice as high as wide and grooved on the sides. Dorsal valve slightly convex; mesial fold low and narrow; cardinal area very narrow. Surface marked by about forty-four or more fine, simple and rounded plications on each valve, few of which reach to the beak.

The Maryland specimens are mostly external impressions found infrequently in arenaceous shales and consequently quite imperfectly preserved. They clearly show, however, the high cardinal area and long

mucronate hinge-line. This species is generally readily distinguished by the high, inclined cardinal area and extended hinge-line. The dorsal valve resembles quite closely some forms of *S. mucronatus,* but the high cardinal area of the ventral valve readily separates them. Young specimens resemble *S. audaculus,* while the mucronate extensions of the hinge-line are rarely preserved in internal impressions so that it is apparently shorter than in other specimens.

Length, 12-15 mm.; width, 50-56 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry (?); east side Warrior Mt. east of Rush; east bank Evitts Creek below Wolfe Mill (?); B. & O. R. R. cut at 21st Bridge.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

SPIRIFER (RETICULARIA) FIMBRIATUS (Conrad)

Plate XIX, Figs. 10-12

Delthyris fimbriatus Conrad, 1842, Jour. Acad. Nat. Sci. Phila., vol. viii, p. 263.

Spirifer fimbriatus Hall, 1858, Geol. Surv. Iowa, vol. i, pt. ii, p. 505, pl. iv, fig. 5.

Spirifera fimbriata Hall, 1867, Pal. N. Y., vol. iv, p. 214, pl. xxxiii, figs. 1-21.

Spirifera conradana Miller, 1883, Amer. Pal. Foss., 2d ed., p. 372.

Spirifera conradana Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.

Spirifer fimbriatus Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, pp. 17, 20, 21, 33, 37, pl. xxxvi, figs. 17-22; pl. xxxviii, figs. 9, 10.

Reticularia fimbriata Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 342.

Spirifer fimbriatus Clarke, N. Y. State Mus., Bull. 65, p. 316.

Reticularia fimbriata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 338, figs. 431a, b.

Description.—Outline transversely subelliptical; hinge-line less than the width of the shell; cardinal angles rounded; valves gibbous and regularly convex. Ventral valve has well defined sinus, usually shallow and rounded, sometimes deep and angular; beak small and incurved over the cardinal area which is high and concave, extending about one-half the width of the shell. Dorsal valve slighly flattened at the cardinal angles; mesial fold abruptly elevated in the lower part, low and frequently but imperfectly defined toward the beak. Surface of each valve marked by

from six to eighteen low, rounded, often obscure plications; concentric imbricating and lamellose striae, which are sometimes distant and frequently crowded; the concentric striae studded with elongated spines or tubercles, which are arranged in parallel bands and may be regarded as interrupted radiating striae.

But few specimens of this species have been found in Maryland and only a single imperfectly preserved ventral valve was available for comparison in compiling the above description. The small number of low, rounded plications, conspicuous concentric striae and concentric rows of tubercles, however, readily distinguish the species from any other found in the Middle Devonian of Maryland.

Concerning the specimens occurring in the Onondaga member, Kindle says: "The collection contains three small specmiens of a Reticularia having a breadth along the hinge-line of about 5 mm. and with 3 to 4 plications on each side of the fold and sinus. These probably represent either immature individuals or a dwarfed form of *R. fimbriata.*"

Length, 15-25 mm.; width, 20-35 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland. HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

SPIRIFER cf. CONSOBRINUS (d'Orbigny)

Plate XIX, Fig. 13

Delthyris ziczac Hall (non Roemer), 1843, Geol. N. Y., pt. iv, pp. 200, 201, fig. 5.

Spirifera consobrina d'Orbigny, 1850, Prodrome Pal., i, p. 98.

Spirifera ziczac Hall, 1867, Pal. N. Y., vol. iv, p. 222, pl. xxxv, figs. 15-23.

Spirifer consobrinus Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, pp. 16, 36, pl. xxxiv, figs. 9, 18; pl. xxxvii, figs. 9, 10.

Delthyris consobrina Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 206.

Spirifer (Delthyris) consobrinus Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 331, figs. 422a, b.

Description.—Shell medium size, gibbous, semielliptical in outline, with the hinge-line equaling or greater than the width of the shell below;

the cardinal extremities truncate or auriculate. Ventral valve the more convex, the greatest convexity being somewhat above the middle; sides regularly curving to the lateral margins, sinus deep and wide towards the front, rounded or flat in the bottom, produced in front, and sharply defined by the adjacent angular plications, which are stronger than the others; beak incurved. Cardinal area elevated and concave. Dorsal valve moderately convex at the sides; the mesial fold abruptly elevated, rapidly expanding below, flattened upon the summit, and usually marked by a mesial depression. Surface marked by from eight to ten or even twelve strong angular plications on each side of the shell, those towards the cardinal extremities being less elevated and often obscure, crossed by concentric zigzag lamellose lines of growth between which are finer lines.

A few specimens have been found in Maryland which are referred provisionally to this species, the best one of which is an internal impression found on Town Creek, about six miles north of Oldtown. The sinus is deep, about as broad as in specimens of this species, and is sharply defined by a plication on each side which is stronger than the others. There are seven prominent plications and two or three inconspicuous ones near the cardinal angle on each side of the shell and the conspicuous plications near the anterior margin of the shell are crossed by prominent concentric zigzag lines. The posterior portion of the impression is pustulose, and the hinge-line is rather longer than the greatest width of the shell. The proportions of this specimen are nearer those of *Spirifer sculptilis* Hall than of this species and the concentric striae are similar to those on the type specimen of *S. sculptilis* in the office of the State Paleontologist of New York; but there are only three plications on that specimen while the number of plications for the species does not exceed five on a side according to the description. The Maryland specimen has nine or ten plications, a character which agrees with *S. consobrinus* and furthermore the sinus is deep and broad as in that species.

Length, 19 + mm.; width, 36 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Town Creek 6 miles north of Oldtown.

Collection.—Maryland Geological Survey.

SPIRIFER SCULPTILIS VAR. MARYLANDENSIS n. var.

Plate XIX, Figs. 14-16

Description.—Rather more than one-half of the dorsal valve and its external impression were found in the Maryland Collection. These specimens show eight angular plications on one side of the mesial fold which is bifurcated by a furrow, the surface is strongly marked by conspicuous imbricating, concentric striae, while the cardinal angle is mucronate with somewhat corrugated surface. These specimens differ from the figures and description of *S. sculptilis* in having a more mucronate cardinal angle and a larger number of plications, eight on a side instead of from three to five.

The specimens were sent to Prof. Schuchert who returned them labeled *Spirifer sculptilis.* They were also examined by Dr. Grabau who sent me the following notes: "They come nearest to *S. sculptilis.* Too many plications. It is more mucronate which is a primitive character with this group of Spirifers, since they are mucronate when young. It has more plications than normal which is an advanced character. Either new species or variety of *S. sculptilis.*" It does not appear to the writer advisable to base a new species upon this imperfect material; but on account of the divergence from the normal forms of the species it is regarded and described as a variety.

Length, 15 mm. ±; width, 44 mm. ±.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East side Warrior Mt. east of Rush.

Collections.—Maryland Geological Survey.

Genus AMBOCOELIA Hall

AMBOCOELIA UMBONATA Conrad

Plate XX, Figs. 1, 2

Orthis umbonata **Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 264, pl. xiv, fig. 4.**

Ambocoelia umbonata **Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 71.**

Ambocoelia umbonata **Hall, 1867, Pal. N. Y., vol. iv, p. 259, pl. xliv, figs. 7-18.**

Ambocoelia umbonata Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Ambocoelia umbonata Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, pl. xxix, fig. 17; pl. xxxix, figs. 4-9.
Ambocoelia umbonata Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 141.
Ambocoelia umbonata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 343, figs. 438c, d.

Description.—Shell plano-convex, almost hemispherical contour, rather wider than long; hinge-line generally equal to the width of the shell; cardinal angles rounded. Ventral valve very gibbous; umbo high and incurved; mesial sinus strong, distinct and continuous from the beak to the front; cardinal area comparatively large, arched and of considerable height. Dorsal valve semielliptical; faintly convex in the upper central part, concave below the middle and at the sides; beak scarcely elevated above the hinge-line; without mesial fold, furrow or impressed line. Surface marked by fine concentric striae which are sometimes crowded and imbricating towards the front of the valves, and by very fine radiating striae which are only shown on excellently preserved specimens and hence are rarely seen.

The Maryland specimens are generally in the condition of impressions although occasionally more or less of the shell is preserved. The impressions of some of the ventral valves show a striated muscular area toward the beak and pustulose markings over the central part of the valve. Some of the specimens are fully as large as any from New York and in fact broader, a condition apparently due to crushing, while others are smaller than the normal ones. The species is readily identified by its smooth surface, with the exception of the concentric and radiating striae the latter of which are shown only on exceptionally well preserved specimens; the very convex ventral valve with its strongly marked median sinus and the nearly flat dorsal valve without ridge or furrow.

Concerning the species found in the Onondaga fauna, Kindle says:

The specimens which are here referred to this species seem to show a considerable range of variation which may possibly include an undescribed species. Although one of the most abundant and widely distributed species in the fauna it usually occurs in soft shales which furnish rather poorly preserved and often flattened material. The character of this material scarcely justifies detailed consideration of the types of variation observed. Hall[1] states that

[1] Pal. New York, vol. 4, 1867, p. 259.

the surface of this species is marked by " very fine radiating and concentric striae." In most of the specimens, both in my collection and in other collections bearing the name *A. umbonata*, the surface is smooth. In some specimens, however, concentric striae are well developed but none have been observed showing radiating striae. Shells with a strongly lamellose dorsal valve are not uncommon. These as well as smooth shells frequently show a distinct fold near the front of the dorsal valve.

Length, 6-10 mm.; width, 8-12 mm. There are some specimens smaller than the normal ones, but apparently belonging to this species, which have a length and width of about 4 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland; Hancock; Hanging Rock, W. Va. HAMILTON MEMBER. Williams Road, 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill; Williams Road, ¼ mile east of Queen City Hotel, Cumberland; in Jennings Run, ½ mile west of Corriganville; Town Creek Road at George Diefenbaugh's; Licking Creek east of Warren Point; on Oldtown Road east of Maryland Ave., Cumberland; Ernstville; in run at Hancock east of Catholic church; along Flintstone Creek in Gilpin; on National Road in Gilpin; west of iron bridge over Town Creek northeast of Oldtown; on Romney-Hanging Rock Road, about ½ mile north of Romney, W. Va.; 1 mile north of Romney, W. Va.; B. & O. R. R. cut at Hancock Station, W. Va.; W. Va. side Potomac River, 4 miles south of Cumberland.

Collections.—Maryland Geological Survey; American Museum of Natural History.

AMBOCOELIA VIRGINIANA n. sp.

Plate XX, Figs. 3-6

cf. *Ambocoelia umbonata* var. cf. *nana* Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 83, pl. v, figs. 20-23.

Description.—Shell very small; plano-convex; hinge-line straight, less than the greatest width of the shell, cardinal angles rounded. Ventral valve gibbous, umbo elevated with incurved beak; a narrow deep mesial sinus which is sharply defined extending from the beak to the front of the shell; part of the specimens show a single plication beginning near the center of the valve, extending to its front and bordering the sinus. Dor-

sal valve slightly convex near the umbo and flattened toward the front; a small fold begins about one third of the length from the umbo, extends to the front of the valve, and near the front is limited on each side by a shallow furrow. Surface marked by concentric and very fine radiating striae.

This shell is similar to a minute form of *Ambocoelia umbonata* (Con.); but it differs from that species in its constant small size and the sharper sides of the sinus. The specimens occur in large numbers forming a large proportion of a thin calcareous stratum and they are uniformly small and similar to the specimen described. The material was shown Dr. J. M. Clarke and it is his opinion that the constant small size and angular sinus entitles this form to rank as a species.

Hall described a form from the Marcellus shale as *Orthis nucleus* (Geol. N. Y., pt. iv, p. 181 and fig. 8 on p. 180), which later was termed *Ambocoelia nucleus* (Thirteenth Report on the State Cabinet p. 71), and finally made a synonym of *Ambocoelia umbonata* (Pal. N. Y., vol. iv, pp. 259, 260), that apparently approaches this species in many respects. Specimens of this form have not been seen by the writer, but it is believed that the species here described is uniformly much smaller. It is to be noted, however, that the description of *Ambocoelia nucleus* states that the sinus "is often very conspicuous, being narrow and sharply depressed" (Pal. N. Y., vol. iv, p. 260); but in the original description is the statement that the upper [dorsal] valve is flat (Geol. N. Y., pt. iv, p. 181) although later it is stated that a diminutive form similar to the *A. nucleus* of the Marcellus shale "sometimes occurs in the compact calcareous beds of the Hamilton group in great numbers . . . . and in these the dorsal valve is more convex than usual" (Pal. N. Y., vol. iv, p. 260).

A virginiana is also somewhat similar to the form which Dr. Grabau first described as variety *nana* of *A. umbonata* (Sixteenth An. Rep. State Geologist [N. Y.], 1899, p. 276, figs. 3-7 on p. 277) from near the base of the Hamilton shales on the shore of Lake Erie in western New York and which he later raised to the rank of a species (Bull. Buffalo Soc. Nat. Sciences, vol. vi, 1899, p. 217, fig. 126 on p. 218). Finally, Miss

Wood has reported the same species from the Stafford limestone in the Marcellus shale of Erie County, N. Y., stating that a thin bed of limestone is largely composed of shells of this species and *Strophalosia truncata* (N. Y. State Museum, Bull. 49, 1901, p. 145, and see p. 165 for description together with figures 21-23 of pl. 9). The surface of this species, however, differs strikingly from that of *A. virginiana* in being spinous as indicated by the numerous elongated pits, the shell is also considerably larger, the average dimensions being given as length 5.3-6 mm. and width 7.2-7.9 mm.; while the dorsal valve is marked by a shallow sinus instead of a low fold with a sinus on each side toward the front as in the latter species.

Occasionally in some of the iron stained shales are small flattened specimens of *Ambocoelia,* which apparently belong to this species. The most numerous specimens of this species seen by the writer occur in a cut on the Romney branch of the B. & O. R. R. between Green Spring and Springfield, about three miles south of Green Spring, W. Va. At this locality is a thin, very dark gray limestone containing large numbers of this species, and they are also abundant in some of the associated brownish shales. This outcrop is in the Marcellus shales of the Romney formation.[1]

Length, 1½ mm.; width 2 mm.

Occurrence.—ROMNEY FORMATION, MARCELLUS MEMBER. One mile east of Oldtown; three miles south of Green Spring, W. Va. HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; W. Va. side Potomac River, 1½ miles below Cumberland.

Collection.—Maryland Geological Survey.

AMBOCOELIA PRAEUMBONA Hall (?)

Plate XX, Figs. 7, 8

Orthis praeumbona Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 167.
Ambocoelia praeumbona Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 71.
Ambocoelia praeumbona Hall, 1867, Pal. N. Y., vol. iv, p. 262, pl. xliv, figs. 1-6.
Ambocoelia praeumbona Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 141.

[1] The specimen figured from south of Green Spring was sent to Kindle who wrote that it was probably a new species.

Ambocoelia praeumbona Clarke, 1903, N. Y. State Mus., Bull. 65, p. 188.
Ambocoelia praeumbona Grabau and Shimer, 1909, N. Am. Index Fossils, vol. 1, p. 342, figs. 438a, b.

Description.—Shell obliquely semiglobose or ovoid, the hinge-line less than the width of the shell; cardinal extremities rounded; surface without plications. Ventral valve extremely convex or ventricose, with a shallow impressed line which has nearly the character of a narrow shallow sinus; beak large and incurved; cardinal area of moderate dimensions, proportionally high, with the lateral margins not defined; fissure partially covered by an arching pseudo-deltidium. Dorsal valve moderately and evenly convex, usually without mesial fold or sinus, the cardinal extremities rounded; sometimes there is a narrow impressed line down the center of the valve. Surface essentially smooth, or marked only by concentric striae, which are sometimes crowded into imbricating folds; the impression of the ventral valve has a large often pustulose muscular area, margined by a thickening of the shell. In many specimens the length and width are nearly equal, the dimensions being about three-fourths of an inch.

A large internal impression of a ventral valve together with a few other imperfect specimens in the Maryland Collection are provisionally referred to this species. In the umbonal region is a well marked sinus which becomes broader and shallower toward the front of the shell; there is also a shallow indistinct furrow between the ridges limiting the sinus and the lateral margin of the shell. Strong concentric wrinkles of growth occur toward the margin and the rather large pustulose muscular area is fairly well shown in the umbonal region. In some respects the specimen suggests an unusually large form of *Ambocoelia umbonata* (Con.), but it was sent to Prof. Schuchert and he wrote me as follows: "This looks more like *A. praeumbona* [than *A. umbonata*] only the sinus is very much marked. However, this character is somewhat due to its being an internal cast of the shell and may not have been so strong on the outside." On re-examination Prof. Schuchert wrote as follows: "At first I was going to label this specimen *A. praeumbona* but the ventral sinus is against this identification. However, the specimens are so

much extended on the hinge and so much larger that I do not think they can be referred to *A. umbonata.* Think about making it a variety if after a study of the material you can find characters sufficiently constant." The specimen was later submitted to Dr. J. M. Clarke who apparently referred it to this species since he wrote "Why not *Ambocoelia praeumbona* Hall?" After this study it appears better to the writer, at present, to refer these specimens with a question to *A. praeumbona.*

Length, 14 mm.; width, 18 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Ernstville.

Collection.—Maryland Geological Survey.

Family ATHYRIDAE

Genus NUCLEOSPIRA Hall

NUCLEOSPIRA CONCINNA Hall

Plate XX, Figs. 12-15

Atrypa concinna Hall, 1843, Geol. N. Y., pt. iv, p. 200, fig. 3.
Nucleospira concinna Hall, 1859, Twelfth Rep. N. Y. State Cab. Nat. Hist., pp. 25, 26.
Nucleospira concinna Hall, 1867, Pal. N. Y., vol. iv, p. 279, pl. xlv, figs. 33-57.
Nucleospira concinna Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Nucleospira concinna Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 145, fig. 131; pl. xlviii, figs. 12-17, 19-34; pl. lxxxiv, fig. 38.
Nucleospira concinna Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 273.
Nucleospira concinna Clarke, 1903, N. Y. State Mus., Bull. 65, p. 263.
Nucleospira concinna Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 349, fig. 454.

Description.—Shells fairly small: bi-convex; nearly circular in outline, the width being usually a little greater than the length; valves subequal; hinge-line about one-third, and sometimes half as long as the width of the shell. Ventral valve regularly convex, the greatest convexity a little above the middle curving regularly to the sides and front; umbo prominent, the beak pointed and incurved over the apex of the dorsal valve; there is generally a narrow depressed line from the beak to the front of the valve. Dorsal valve regularly convex, becoming a little depressed toward the front, the greatest convexity a little above the center; there is usually a depressed line along the middle of the valve.

Surface usually smooth or very finely papillose, but in its perfect condition covered by numerous fine seta.

The Maryland specimens are rather poorly preserved internal impressions which occur infrequently. They show distinctly a shallow furrow which extends from the vicinity of the beak to the front of the ventral valve, produced by the internal medium septum. This species is distinguished by its small size, nearly circular outline, subequally convex valves, generally smooth surface, and median furrow of internal impressions, especially of ventral valve.

Concerning the specimens found in the Onondaga, Kindle states:

This species is represented by numerous ventral valves but the dorsal valve has not been observed. Nearly all of the specimens represent casts of the interior but one silicified specimen shows the base of the fine setae over the anterior third of the shell and a highly papillose surface over the remainder of the shell. The outline of the muscular scars is not very clearly shown in the specimens. Two narrow ridges on either side of the septum appear to represent them in the casts.

Length, 10 mm.; width, 11 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland; Tonoloway. HAMILTON MEMBER. Ernstville.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Genus ANOPLOTHECA Sandberger

Subgenus COELOSPIRA Hall

ANOPLOTHECA (COELOSPIRA) ACUTIPLICATA (Conrad)

Plate XX, Figs. 16-23

Atrypa acutiplicata Conrad, 1841, Fifth Ann. Rep. N. Y. Geol. Survey, p. 54.
Atrypa acutiplicata Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., 1862, pl. xi, fig. 17.
Leptocoelia acutiplicata Hall, 1867, Pal. N. Y., vol. iv, p. 365, pl. lvii, figs. 30-39.
Anoplotheca (Coelospira) acutiplicata Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 136, pl. liii, figs. 32-39.
Anoplotheca acutiplicata Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 144.

Coelospira acutiplicata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 214.
Anoplotheca acutiplicata Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 84, pl. vi, figs. 1-15.

Description.—The shell is plano-convex, compressed and of moderate size. The ventral valve is moderately convex, with the beak slightly incurved.[1] The dorsal valve is depressed-convex, sometimes flat or concave from compression. Surface marked by from six to eight strongly angular plications; on the ventral valve two plications are slightly elevated, giving an abrupt sinuosity in front, while the central one on the dorsal valve is depressed and margined on each side by a larger one. The shell is concentrically marked by strong imbricating lines of growth.

This species has previously been considered as confined to the Onondaga (Corniferous) limestone; with the exception that it is doubtfully identified by Dr. Weller from the Monroe shales at Greenwood Lake, New Jersey, which he apparently considered as of Hamilton age.[2] There is apparently no doubt regarding the correctness of the identification of the Maryland specimens for they were submitted to Dr. J. M. Clarke who identified them as belonging to this species, a conclusion fully corroborated by subsequent study. The Maryland specimens are principally impressions preserved in bituminous shales which are considerably more flattened than the specimens from the Onondaga limestone. Gutta-percha impressions of some of these specimens, however, reproduce very nearly the form and markings of the dorsal and ventral valves of this species as shown by figures 34 and 35 of plate lvii, vol. iv, Palæontology of New York. The plications have almost identically the same form and strength as those of the figures just mentioned, are nine or ten in number and rather broad and sharply marked by the imbricating concentric lines.

[1] In Professor Hall's description the terms dorsal and ventral are applied to the opposite valves as compared with this description as may readily be seen by referring to the description on p. 365, vol. iv, Palæontology, N. Y., and especially by consulting figures 34 and 35 of plate 57 which are called respectively dorsal and ventral valves. Hall and Clarke, however, reversed the naming of these valves in pt. ii, vol. viii, Palæontology, N. Y., where on plate 53, fig. 35 ventral valve of vol. iv reappears as fig. 32 which is called dorsal and fig. 34 dorsal of vol. iv as ventral valve of fig. 34 of vol. viii.

[2] Geol. Surv. N. J., Rep. on Paleontology, vol. iii, 1903, pp. 106, 107, 383.

This species is characterized by its plano-convex to nearly flat shape, ovate to orbicular form, eight to ten rather broad and rounded plications crossed by sharp imbricating lines, the central plication on the dorsal valve considerably depressed and bordered on each side by the strongest one of the valve, while on the ventral valve two plications are somewhat depressed in a broader and more shallow sinus the boundaries of which are not indicated by two as prominent plications as on the dorsal valve.

Kindle repeats that this is probably the most abundant and widely distributed species in the Onondaga fauna, occurring in most of the collections from New York to southwestern Virginia.

Length, 10-14 mm.; width, 14-17 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. B. & O. R. R. cut at 21st Bridge; Williams Road, 3½ miles southeast of Cumberland. HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; American Museum of Natural History; U. S. National Museum.

ANOPLOTHECA CAMILLA (Hall)

Plate XX, Fig. 24

Coelospira concava **Hall, 1867 (non Hall 1863), Pal. New York, vol. 4, 1867, p. 329.**
Coelospira camilla **Hall, 1867, *ibidem*, pl. 52, figs. 13-19.**
Anoplotheca camilla **Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 85.**

This rather diminutive brachiopod is represented by only a few positively determined specimens in the collection. Although comparatively rare it has been found both in the non-calcareous shale and the limestone in three states and is probably coextensive with the Onondaga fauna in its distribution.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Genus VITULINA Hall

VITULINA PUSTULOSA Hall

Plate XX, Figs. 25, 26

Vitulina pustulosa Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 82.

Vitulina pustulosa Hall, 1867, Pal. N. Y., vol. iv, p. 410, pl. lxii, figs. 1*a*-1*i*.

Vitulina pustulosa Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, pp. 139, 317, pl. lxxxii, figs. 18-25.

Vitulina pustulosa Prosser, 1894, Bull. U. S. Geol. Surv., No. 120, p. 21.

Vitulina pustulosa Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 459.

Vitulina pustulosa Clarke, 1903, N. Y. State Mus., Bull. 65, p. 345.

Vitulina pustulosa Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 351, fig. 458.

Description.—Shell subplano-convex, semielliptical; hinge-line equaling or a little less than the width of the shell. Ventral valve convex; median part raised in a broad fold which is subangular to flat near the beak and grooved along the center to the front of the valve, with four or five rounded or subangular plications on each side; delthyrium large and wide, reaching to the apex. Dorsal valve flat or slightly convex, with a wide mesial depression which is nearly flat in the bottom, and in large specimens contains a simple or double low plication toward the front; plications on the side similar to those of the ventral valve; very narrow cardinal area. Surface marked by interrupted radiating lines which form rows of elongated pustules; substance finely punctate.

This is a rare species in Maryland but a few impressions have been found on the National Road to the northeast of Cumberland. They are mainly specimens of the ventral valve and one agrees quite closely with the "ventral valve of a large individual" figured by Hall.[1] The proportion of the width to the length of another specimen is somewhat greater than in the New York specimens, while a fragment of an external impression shows beautifully the impressions of the elongated pustules. The author found abundant specimens of this species at Marshalls Falls, Monroe Co. in northeastern Penna.; while there is a specimen of an internal impression of a small ventral valve from Perry Co., Penna., in

[1] Pal. N. Y., vol. iv, pl. lxii, fig. 1*a*.

the Geological Museum of the Ohio State University. This species is distinguished by its shape, size, small number of rounded plications, fold on ventral with sinus on dorsal valve, and pustulose surface.

Length, 9 mm.; width, 12 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; Williams Road, 3½ miles southeast of Cumberland (?); on Oldtown Road east of Maryland Ave., Cumberland; on National Road northeast of Cumberland; on road about half way between Romney and Hanging Rock, W. Va.; on Romney-Hanging Rock Road about ½ mile north of Romney, W. Va.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Genus ATHYRIS McCoy

ATHYRIS SPIRIFEROIDES (Eaton)

Plate XXI, Figs. 1, 2

Terebratula spiriferoides Eaton, 1831, Am. Jour. Sci., vol. xxi, p. 187.
Atrypa concentrica Conrad, 1838, An. Rep. Geol. Surv. N. Y., p. 111.
Atrypa concentrica Hall, 1843, Geol. N. Y., pt. iv, p. 198, figs. 5, 5*a*.
Spirifera spiriferoides Hall, 1857, Tenth Rep. N. Y. State Cab. Nat. Hist., p. 153, figs. 1, 2.
Spirifera spiriferoides Rogers, 1858, Geol. Penna., vol. ii, pt. ii, p. 828, fig. 667.
Athyris spiriferoides Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 93, figs. 1-4.
Athyris spiriferoides Hall, 1867, Pal. N. Y., vol. iv, p. 285, pl. xlvi, figs. 5-31.
Athyris spiriferoides Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Athyris spiriferoides Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 89, figs. 60, 61; pl. xlv, figs. 11-27.
Athyris spiriferoides Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 149.
Athyris spiriferoides Clarke, 1903, N. Y. State Mus., Bull. 65, p. 192.
Athyris spiriferoides Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 353, fig. 461.
Not *Terebratula concentrica* von Buch.

Description.—Shell varying from transversely oval to suborbicular and sometimes subquadrate; hinge-line short; the cardinal extremities rounded. Ventral valve moderately gibbous, often regularly convex above the middle, and deeply sinuate toward the front; umbo gibbous, beak

incurved and covering that of the opposite valve; apex perforate; the interior shows two strong teeth; the muscular impressions begin at the base of the rostral cavity, and continue to a little below the middle of the length of the valve; outside the muscular impression the surface is often variously marked by vascular impressions. Dorsal valve gibbous, much more convex than the opposite valve; umbo prominent; outline regularly convex above the middle and curving abruptly to the sides; the usually undefined mesial fold becomes visible below the middle of the valve, and usually very conspicuous toward the front, which is abruptly elevated. Surface marked by concentric lines of growth, the lamellae often closely imbricated and sometimes nearly wanting near the umbo but crowded toward the front of the shell; well preserved specimens occasionally marked by fine interrupted and scarcely distinct radiating striae.

The majority of the Maryland specimens are internal impressions; but there are a few in which the shell is more or less perfectly preserved. A ventral valve of the latter closely agrees with the more oval form of this species from the Hamilton formation of New York and there are internal impressions very similar to the ventral one figured by Hall from Hardy County, Va.[1] The specimens are not so gibbous as those from the calcareous shales of western New York, and perhaps this difference is partly due to crushing in connection with the folding of the Maryland rocks. The species is distinguished by the size, shape, greater convexity of dorsal valve, broad and shallow sinus on anterior part of ventral valve which is often deep near the margin forming a nasute front; conspicuous surface lamellae; and the outline of the muscular impressions on the interior of the valves or internal impressions.

Length, 32 mm.; width, 33 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; B. & O. R. R. cut at 21st Bridge; west of iron bridge over Town Creek northeast of Oldtown.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

[1] Pal. N. Y., vol. iv, pl. xlvi, fig. 29.

Genus MERISTELLA Hall

MERISTELLA (?) sp.

Plate XXI, Figs. 3, 4

Description.—Shell ovoid, minute. Ventral valve very gibbous in the umbonal region and along the median line to its front but sloping steeply from this line toward the lateral margins. No evidence of punctate structure and surface smooth with the exception of fine concentric lines and perhaps very fine radiating striae. Dorsal valve (?) (associated with the gibbous valve are a number of smaller ones, differently marked which perhaps are dorsal valves of this species), with clearly marked concentric lines of growth, four or five rather indistinct folds and very fine radiating striae.

This minute shell was doubtfully referred to the genus *Meristella* by the writer in the preliminary identification and further study has failed in locating it more accurately. He has also availed himself of the kindness of Prof. Schuchert and Doctors J. M. Clarke and Grabau—to secure their opinions, given below, regarding the systematic position of these specimens. "I should say that these specimens are of the genus *Meristella*. There is no punctate shell and therefore not a *Centronella*. I don't know this shell." Schuchert. "Valve looks like *Centronella*. Shell texture does not agree therewith. I am not familiar with this shell. Might be called *Meristella* provisionally." Clarke. "I have been trying to satisfy myself that the small Brachiopod is a *Meristella*. I don't know what else it can be unless it is a *Centronella*. It does not compare well with any form I know—may it not be a young *Centronella?*" Grabau.

Length, 3 mm.; width, about 2 mm.

Occurrence.—ROMNEY FORMATION, MARCELLUS MEMBER. W. Va. Cent. R. R. cut at 21st Bridge. HAMILTON MEMBER. West of iron bridge over Town Creek northeast of Oldtown (?).

Collection.—Maryland Geological Survey.

MOLLUSCA[1]

CLASS PELECYPODA

Order PRIONODESMACEA

Family SOLEMYACIDAE

Genus PHTHONIA Hall

PHTHONIA SECTIFRONS (Conrad)

Plate XXI, Figs. 5-7

Cypricardites sectifrons Conrad, 1842, Jour. Acad. Nat. Sci., Phila, vol. viii, p. 245, pl. xiii, fig. 8.
Phthonia sectifrons Hall, 1870, Prelim. Notice Lamellibranchiata, 2, p. 70.
Phthonia sectifrons Hall, 1885, Pal. N. Y., vol. v, pt. 1, Lamellibranchiata ii, p. 475, pl. lxxviii, figs. 10-13.
Phthonia sectifrons Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Phthonia sectifrons Clarke, 1903, N. Y. State Mus., Bull. 65, p. 489.

Description.—"Shell above the medium size, elongate, subelliptical, somewhat obovate; length more than twice the height measured at the posterior end; basal margin nearly straight in the middle, curving gradually at the anterior and more abruptly at the posterior end; anterior end short, narrowly rounded; posterior extremity rounded below, oblique and subtruncate above. Valves depressed, convex along the basal and posterior portions, becoming somewhat gibbous in the middle and above; beaks subanterior, small, low and appressed; umbonal slope obtusely subangular in the upper part; above this, and slightly diverging, is another low ridge extending to the middle of the posterior end. Surface marked by fine concentric striae, and by numerous fine radii extending from the beak to all parts of the shell, which are stronger on the umbonal ridge and anterior end than those on the middle of the shell; at the crossing of the radii and concentric striae, the test is raised into minute elongate nodes." Hall, 1885.

A broken external impression of a left valve of this species was found on the Williams Road near the Church 3½ miles southeast of Cumberland. It was compared with the type specimens in the office of the N. Y.

[1] Contributed by Charles S. Prosser with the addition of Onondaga species by E. M. Kindle as indicated.

State Paleontologist and is apparently correctly identified. This species is readily distinguished by its elongate form, fine concentric striae and radii with stronger radii on the umbonal ridge and anterior end.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road 3½ miles southeast of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Family SOLENOPSIDAE

Genus PROTHYRIS Meek

PROTHYRIS LANCEOLATA Hall

Plate XXI, Figs. 8-10

Prothyris lanceolata Hall, 1883, Pal. N. Y., vol. v, pt. 1, plates and expla., pl. lxxvi, figs. 2-8.

Prothyris lanceolata Hall, 1885, Pal. N. Y., vol. v, pt. 1, Lamellibranchiata ii, p. 460, pl. lxxvi, figs. 2-8.

Prothyris lanceolata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 492.

Prothyris lanceolata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. 1, p. 377, fig. 477e.

Description.—Shell of medium size, elongate-lanceolate; length three times the height; basal margin very gently curving, often nearly straight on the anterior half; posterior extremity pointed, very obliquely truncate above; anterior end truncate, margin reflexed, with a slight constriction behind it and without any conspicuous limiting notch; cardinal line about two-thirds the length of the shell. Valves moderately convex in the posterior part, gibbous in the middle and umbonal portions; beaks subanterior, not prominent, slightly incurved; umbonal slope angular above, extending to the posterior extremity, often merging into the general convexity of the shell below the middle; post-cardinal slope narrow, slightly concave. Surface marked by fine concentric striae, which are sometimes somewhat fasciculate, producing gentle undulations.

A single good specimen of the right valve of this species was found in the blue shales on the West Virginia bank of the Potomac about three miles south of Cumberland. The species is readily recognized by its elongate lanceolate form, truncate and reflexed anterior margin with a

slight constriction behind it, angular umbonal ridge and pointed posterior end.

Length, 23 mm.; height, 6 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry; southwest of McCoys Ferry; west of Lock No. 56 at Great Cacapon; W. Va. side Potomac River about 3 miles south of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Genus ORTHONOTA Conrad

ORTHONOTA UNDULATA Conrad

Plate XXI, Figs. 11-13

Orthonota undulata Conrad, 1841, Geol. Surv. N. Y., An. Rep., p. 51, fig. 6.
Orthonota undulata Vanuxem, 1842, Geol. N. Y., pt. iii, p. 150, fig. 2.
Orthonota undulata Rogers, 1858, Geol. Penna., vol. ii, pt. ii, p. 827, fig. 661.
Orthonota undulata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 87.
Orthonota undulata Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 478, pl. lxxviii, figs. 37-42.
Orthonota undulata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 469.
Orthonota undulata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 378, fig. 480.

Description.—" Shell large, extremely elongate, with parallel dorsal and ventral margins; length three times the greatest height; basal margin nearly straight; slightly constricted anterior to the middle; posterior end somewhat vertically truncated; anterior end short, extending for a little distance along the hinge-line and abruptly rounded; cardinal line straight, extending for about three-fourths the length of the shell. Valves of moderate convexity; beaks subanterior small, low, scarcely elevated above the hinge-line; cincture narrow, distinct, extending from the beak to the basal margin, which is sometimes gently constricted; umbonal ridge prominent, rounded, limited below by a narrow furrow, and extending to the post-inferior extremity; cardinal slope wide, marked by a distinct fold along the middle of its length. Surface marked by fine concentric striae, which are in some parts crowded and fasciculate on the body of the shell; marked by distinct undulations upon the anterior end and post-cardinal slope." Hall, 1885.

Several well defined specimens of this species were found in the Hamilton shales of Washington County. It is an easily recognized species from its elongate form, parallel dorsal and ventral margins, umbonal ridge and furrow, ridge and furrows on cardinal slope and the conspicuous undulations of the anterior end and cardinal slope.

Length, 33-45 + mm.; height, about 12 mm. at posterior extremity.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at Hancock Station, W. Va.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

ORTHONOTA (?) PARVULA Hall

Plate XXII, Figs. 1, 2

Orthonota parvula Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 88.
Orthonota (?) *parvula* Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 482, pl. lxv, figs. 2, 3; pl. lxxviii, figs. 29-32.
Orthonota (?) *parvula* Clarke, 1903, N. Y. State Mus., Bull. 65, p. 468.

Description.—"Shell small, elongate subtrapezoidal; length three times the height; ventral and dorsal margins straight and subparallel; posterior extremity vertically or obliquely truncate below and curving forward above; anterior end narrowly and regularly rounded from the cardinal margin. Valves moderately convex below and posteriorly, becoming gibbous in the middle and umbonal regions; beaks at about the anterior fourth, flattened and incurved, rising very little above the hinge-line; umbonal slope angular, extending to the post-inferior extremity; post-cardinal slope flat or slightly concave; sometimes obscurely marked by a depression or fold below the middle. Surface marked by extremely fine, thread-like concentric striae, which are often lamellose on the post-cardinal slope." Hall, 1885.

The blue shales of Evitts Creek below Wolfe Mill have furnished a few clearly marked specimens of this easily recognized species, although smaller than the average of those found in New York. Its most marked characters are the elongate, subtrapezoidal form; straight ventral and dorsal margins; angular umbonal ridge; flat to slightly concave post-

cardinal slope; and fine surface striae without the undulations of *O. undulata*.

Length, 10 mm.; height, 3 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Family GRAMMYSIIDAE

Genus GRAMMYSIA de Verneuil

GRAMMYSIA BISULCATA (Conrad)

Plate XXII, Fig. 3

Pterinea bisulcata Conrad, 1838, Geol. Surv. N. Y., An. Rep., p. 116.
Cypricardites bisulcata Conrad, 1841, Geol. Surv. N. Y., An. Rep. p. 52.
Grammysia hamiltonensis de Verneuil, 1847, Bull. Soc. Géol., France, 2d sér., tome iv, p. 696.
Grammysia bisulcata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 49.
Grammysia bisulcata Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 359, pl. liv, figs. 1-16; pl. lvi, fig. 1; pl. xciii, fig. 25.
Grammysia bisulcata Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Grammysia bisulcata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 397.
Grammysia bisulcata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 381, fig. 485b.

Description.—" Shell large, ovoid; length once and a half the height; basal margin broadly curved; with a constriction near the middle of its length; posterior margin abruptly rounded below and broadly curving or subtruncate above; anterior end abruptly rounded below the deep lunule; cardinal line nearly straight, more than half as long as the shell. Valves regularly convex below and gibbous or ventricose in the middle and above; beaks subanterior, strong, incurved over the cardinal line; umbo prominent, gibbous, with a cincture consisting of a strong fold with a furrow on each side, extending from the beak to the basal margin at about the middle of its length. Surface marked by fine concentric striae, which, on some portions of the shell, are aggregated into fascicles; and by strong persistent concentric ridges or folds, which are stronger upon the anterior part of the shell and distinctly undulated in crossing the cincture." Hall, 1885.

A very much distorted specimen was found at McCoys Ferry in Washington County, which is referred to the above species. The specimens are so badly crushed and poorly preserved that it is not advisable to attempt any description.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry; southwest of McCoys Ferry; on National Road northeast of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

GRAMMYSIA ARCUATA (Conrad)

Plate XXII, Figs. 4-10

Posidonia (?) *arcuata* Conrad, 1841, Geol. Surv. N. Y., An. Rep., p. 53.
Grammysia arcuata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 56.
Grammysia arcuata Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 373, pl. lxi, figs. 1-9; pl. lxiii, fig. 6 (?), pl. xciii, fig. 27.
Grammysia arcuata Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Grammysia arcuata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 396.
Grammysia arcuata Clark and Mathews, 1906, Md. Geol. Surv., vol. vi, pl. xvii, fig. 10.
Grammysia arcuata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 383, figs. 486e, f.

Description.—"Shell of medium size, ovate; length about one-third greater than the height; basal margin moderately curved, straight or slightly concave along the middle; posterior extremity regularly rounded; anterior end varies from regularly and narrowly rounded to obliquely truncate below and abruptly rounded above; cardinal line nearly straight, slightly declining posteriorly. Valves regularly convex below and posteriorly, becoming gibbous above and in the umbonal region; beaks subanterior, large and prominent, inclined forward; umbonal ridge not defined. Surface marked by fine, close concentric striae and by strong rounded or subangular concentric undulations which are usually continuous from the lunule to the margin of the escutcheon; these undulations are sometimes duplicated, or others intercalated on the anterior half of the shell, which are thence continuous to the posterior termination." Hall, 1885.

The Maryland specimens are fragmentary or badly distorted by pressure; but they have the strong undulations with intercalated ones, prominent beaks and some of the other characters which characterize this species. Furthermore, the species was identified by Hall from the soft shales of the Hamilton group at Pattersons Creek, [West] Virginia (Pal. N. Y., vol. v, pt. i, Lamellibranchiata II, p. 374).

Length, 40 mm.; height, 20 mm. or more, specimen badly crushed.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Town Creek about 6 miles north of Oldtown; Pine Hill 5 miles north of Oldtown; McCoys Ferry; southwest of McCoys Ferry; Williams Road, 3½ miles southeast of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

GRAMMYSIA sp.

Description.—This genus is represented in the Onondaga of Maryland by a single specimen showing only the anterior portion of a right valve. It represents a species of the same general type as *G. subarcuata.*

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

GRAMMYSIA CIRCULARIS Hall (?)

Plate XXIII, Figs. 1-3

Grammysia circularis Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 51.
Grammysia circularis Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 364, pl. lvii, figs. 3-6; pl. lviii, fig. 13.
Grammysia circularis Clarke, 1903, N. Y. State Mus., Bull. 65, p. 398.
Grammysia circularis Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 383, fig. 486g.

Description.—Shell varying from medium to large size, subcircular in outline, ventricose; length about one-fifth greater than the height; basal margin regularly rounded, except a slight sinuosity posterior to the

middle; posterior margin regularly rounded from the post-inferior extremity to the cardinal line which is short and rounded; anterior end short and narrow, regularly curving from the lunule into the basal margin. Valves regularly convex along the lower portion, becoming gibbous and ventricose above and in the umbonal region; beaks subanterior, prominent and strongly incurved; the beak and umbo marked by a cincture, consisting of a ridge and shallow furrows, which becomes somewhat obsolete on the middle of the valve, but is continued to the basal margin, marking the shell in its passage by an undulation in the striae which produces a slight projection in the center, with a shallow constriction posterior to it and these features alternate in the two valves. Surface marked by fine concentric striae, which become fasciculate toward the base and on the anterior end, forming distinct ridges or undulations of the surface; no radiating striae have been observed; the hinge has a strongly marked ligamental area extending half the length of the shell, and a well defined lunule. The species is readily distinguished by its subcircular outline, and absence of a distinct cincture below the middle of the valve.

A single, exfoliated, imperfect left valve from the B. & O. R. R. cut at 21st Bridge is doubtfully referred to this species on account of its general resemblance and marked subcircular outline. It shows fine concentric striae and also distinct undulations which are much more conspicuous on the anterior than the posterior part of the specimen.

The outline is too imperfect to give correct proportions; but the specimen as preserved has a length of about 68 mm. and height of 65 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge; on Hancock-Harrisonville Road about 2 miles north of Hancock.

Collection.—Maryland Geological Survey.

Genus EUTHYDESMA

EUTHYDESMA sp.

Description.—An indeterminate species of the genus Euthydesma occurs in the Onondaga fauna at Cumberland.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Genus TELLINOPSIS Hall

TELLINOPSIS SUBEMARGINATA (Conrad)

Plate XXII, Figs. 11, 12

Nuculites subemarginata Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 249, pl. xv, fig. 5.

Tellinopsis subemarginata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 80.

Tellinopsis subemarginata Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 464, pl. lxxvi, figs. 21-31.

Tellinopsis subemarginata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 521.

Tellinopsis subemarginata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 386, fig. 488d.

Description.—"Shell large, elliptical, subquadrate; length more than once and a half the height; basal margin straight or gently curving; posterior extremity subemarginate in the middle and rounded above and below, sometimes truncate or rounded with no emargination; anterior end regularly rounded, large, usually equaling or greater than the posterior half of the shell; cardinal line gently arcuate. Valves moderately convex below and toward the extremities, becoming gibbous in the middle and umbonal region; beaks subcentral, rather prominent, elevated above the hinge-line and incurved; umbonal slope rounded, distinct, defined above by a depression which is sometimes a furrow extending from the beak to the middle of the posterior margin or below, producing a slight emargination. Surface marked by fine concentric striae, which are sometimes fascicled, producing undulations of the surface, and also by radiating striae which are more or less distinct." Hall, 1885.

A few well preserved specimens of this species have been found in the bluish somewhat arenaceous shales of Evitts Creek below Wolfe Mill and on the southern bank of the Potomac River three miles below Cumberland. The flattened space, limited on each side by a low ridge, which extends from the anterior side of the umbo to the antero-basal margin of some of

the New York specimens is but imperfectly shown, if at all, on these specimens. But the following distinctive characters are present: subcentral beaks; subemarginate posterior end; oblique depression extending from the beak to the posterior margin; large rounded anterior end; fine concentric and, on part of the specimens, fine distant radiating striae.

Length of three specimens, 22, 30 and 33 mm.; height, 12, 17, and 20 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road, 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill; on Oldtown Road, east of Maryland Ave., Cumberland; W. Va. side Potomac River about 3 miles south of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Family CARDIOLIDAE

Genus PANENKA Barrande

PANENKA ALTERNATA Hall

Plate XXIV, Fig. 1

Panenka alternata **Hall, 1885, New York State Geol. Surv., Paleontology, vol. v, pt. 1, Lamellibr., pp. 416, 417, text fig. 462.**

Description.—Shell very large, with broadly ovate outline and moderately convex. Surface marked by about 40 strong radii which are subangular in the umbonal region but which become broadly rounded or flattened in the posterior and marginal portions of the shell. In the extreme posterior marginal region they are obsolescent. The radii are separated by broad flat interspaces and crossed by very fine concentric striae.

The collection contains a single right valve which appears to be identical with the shell figured and described by Hall.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. One mile east of Oldtown.

Collection.—U. S. National Museum.

[E. M. Kindle.]

PANENKA cf. DICHOTOMA Hall

Plate XXIII, Fig. 5

Cardiola ? dichotoma Hall, 1883, Pal. N. Y., vol. v, pt. 1, plates and explanations, pl. 70, fig. 21.

Panenka dichotoma Hall, 1885, New York State Geol. Surv., Paleontology, vol. v, pt. i, Lamellibr., p. 416, pl. lxx, fig. 21; pl. xciv, fig. 13.

Description.—A fragmentary right valve which is shown in the figure is believed to represent this species. The imperfection of the specimen, however, scarcely permits of definite specific determination.

Beak prominent, incurved and distinctly directed forward. Surface marked by prominent, rather slender, closely placed plications which occasionally bifurcate. Fine concentric striae cross the plications.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. One mile east of Oldtown.

Collection.—U. S. National Museum.

[E. M. Kindle.]

PANENKA OBSOLESCENS n. sp.

Plate XXIV, Figs. 2, 3

Description.—Shell large, broadly ovate, depressed convex, length exceeding the height. Pallial margin regularly rounded from the anterior to the middle of the posterior end whence it extends in a nearly straight line to the hinge-line, curving slightly forward before reaching it. Hinge-line long and straight. Surface marked by fine concentric striae and numerous radii which become obsolescent in the posterior third of the shell. The resulting smooth, nearly flat posterior third of the shell, together with the nearly straight upper half of the posterior margin nearly vertical to the hinge-line, are the distinctive features of the species which sharply distinguish it from any other shell known to the author. The species is represented by a single right valve; this has the beak broken away so that its shape and extension as suggested by the line in the figure can only be inferred.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. One mile east of Oldtown in cut of Western Maryland Railroad.

Collection.—U. S. National Museum.

[E. M. Kindle.]

PANENKA cf. MULTIRADIATA Hall

Plate XXIII, Fig. 11

Panenka multiradiata Hall, 1885, Pal. N. Y., vol. v, pt. 1, p. 417, pl. lxix, fig. 5; pl. xciv, fig. 18.

Description.—Shell large, subcircular or broadly ovate; length greater than the height. Pallial margin regularly rounded from the anterior to the middle of the posterior end, whence it is a little more abruptly curving to the post-cardinal extremity. Anterior end short and regularly rounded. Posterior end expanded. Valves regularly convex below, becoming gibbous or ventricose in the middle and above. Hinge-line short, straight. Ligamental area short and high. Test thin. Surface marked by numerous, closely arranged, flattened or convex radii. Hall, 1885.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. One mile east of Oldtown in cut of Western Maryland Railroad.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Family PRAECARDIIDAE

Genus BUCHIOLA Barrande

BUCHIOLA HALLI Clarke

Plate XXIII, Fig. 4

Glyptocardia speciosa Hall, 1885, Pal. N. Y., vol. v, pt. 1, Lamellibranchiata ii, pl. lxx, fig. 9; pl. lxxx, fig. 10.

Buchiola halli Clarke, 1904, N. Y. State Mus., Mem. vi, pt. 2, p. 301, pl. x, figs. 15, 16.

Description.—Shell rather small, length greater than the height so that the valve is somewhat elliptical in outline, basal margin regularly curving, convexity regular and greater toward the beak. Surface marked by 11 or 12 broad plications, ½ mm. in width on the median portion of the shell, which are limited laterally by an angular slightly raised ridge; the plications are crossed by conspicuous striated raised ridges which are not so strong on the lateral margins and fail toward the basal one, while the ridges are separated by depressions; between the plications are slightly narrower, smooth evenly rounded furrows which show no indication of the

conspicuous concentric ridges of the plications, the character which distinguishes this species from the other Buchiolas.

Length, 7 mm.; height, 6 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; American Museum of Natural History.

BUCHIOLA RETROSTRIATA (von Buch)[1]

Occurrence.—ROMNEY FORMATION, MARCELLUS MEMBER. 21st Bridge.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Superfamily NUCULACEA

Family NUCULIDAE

Genus NUCULA Lamarck

NUCULA CORBULIFORMIS Hall

Plate XXIII, Figs. 6-10

Nucula corbuliformis Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 2.
Nucula corbuliformis Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 319, pl. xlvi, figs. (10, 11 ?), 24-34 (35-37 ?).
Nucula corbuliformis Clarke, 1903, N. Y. State Mus., Bull. 65, p. 460.
Nucula corbuliformis Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 396, fig. 503f.

Description.—" Shell of medium size, or smaller, broadly triangular, subovate; length about one-fourth greater than the height; basal margin broadly curving, more abruptly rounded at the posterior extremity; anterior end sloping rapidly from the beaks and rounded below; posterior end longer and more pointed; cardinal line declining from the beaks in both directions. Valves convex, gibbous in the umbonal region; beaks usually at about the anterior third, sometimes subcentral, short, moderately elevated, broad and slightly incurved; umbonal slope not distinctly

[1] For description and synonymy of this species see page 613.

defined, rounded, direct, extending to the post basal extremity. Surface marked by very fine concentric striae, and by irregular varices of growth, which sometimes produce strong undulations in the surface of the shell." Hall, 1885.

This is one of the most abundant species of *Nucula* found in Maryland and most of the variations represented by the figures of the New York specimens occur. The larger specimens from the arenaceous shales of Evitts Creek below Wolfe Mill are somewhat flattened and show prominent varices of growth between which are the fine concentric striae; while specimens from the West Virginia side of the Potomac River three miles below Cumberland are rather smaller, not compressed and quite gibbous in the umbonal region. This species is readily identified from the position of the beaks, its subequilateral triangular form, fine concentric striae and irregular varices.

Length, 10-19 mm.; height, 8½-15 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge; W. Va. Cent. R. R. cut at 21st Bridge. Williams Road, 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill; in Jennings Run ½ mile west of Corriganville; on east side Warrior Mt. east of Rush; on Oldtown Road east of Maryland Ave., Cumberland; McCoys Ferry; southwest of McCoys Ferry; on Hancock-Harrisonville Road about 2 miles north of Hancock; Ernstville; W. Va. side Potomac River 3 and 4 miles south of Cumberland; on Romney-Hanging Rock Road about ½ mile north of Romney, W. Va. (?); hill 3 miles south of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

NUCULA BELLISTRIATA (Conrad)

Plate XXV, Figs. 1-5

Nuculites bellastriata Conrad, 1841, Geol. Surv. N. Y., An. Rep., p. 40.
Nucula bellastriata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 2.
Nucula bellistriata Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 318, pl. xlvi, figs. 1-9.

Nucula bellistriatus **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 459.**
Nucula bellistriata **Grabau and Shimer, 1909, N. Am. Index Fossils, vol. 1, p. 395, fig. 503e.**

Description.—" Shell of medium size, broadly ovate, usually somewhat wider behind; length about one-fourth greater than the height; basal margin regularly curving; posterior end broad and rounded; anterior end short, declining rapidly from the beaks, and abruptly rounded below; cardinal line oblique and arcuate. Valves convex, gibbous on the umbo; beaks at about the anterior fourth, appressed, rising above the hinge-line, directed forward; umbonal slope rounded, extending from the beaks in an arching direction, to above the post-basal extremity. Surface marked by fine, regular, sharp, concentric striae, which do not appear to be aggregated into fascicles, but are sometimes interrupted, and the surface undulated by strong varices of growth." Hall, 1885.

The Maryland specimens are mostly somewhat smaller than the figured specimens from New York and again their proportionate length is hardly so great. Still it is thought that they belong to this species which is distinguished by its outline, position of the beak and regular concentric striae, while some of the specimens show varices of growth as represented on figs. 2, 6 and 7 of pl. xlvi of the Palæontology of New York. The internal impression represented by figures 4 and 5 was identified as this species by Dr. Grabau, and it is essentially smooth with the exception of the conspicuous anterior and posterior muscular impressions which are somewhat wrinkled, the beaks are distant and a thin sharp ridge marks the hinge-line from the anterior to the posterior muscular impression.

Length, 7-15 mm.; height, 6-12 mm.

Occurrence.—ROMNEY FORMATION. HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge (?). Williams Road, ¼ mile east of Queen City Hotel, Cumberland; on National Road, ½ mile west of Tonoloway Ridge; on Oldtown Road, east of Maryland Ave., Cumberland; east bank of Evitts Creek below Wolfe Mill; along Flintstone Creek in Gilpin; 1 mile north of Romney, W. Va.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

NUCULA LIRATA (Conrad)

Plate XXV, Figs. 6-8 and 9, 10 (?)

Nuculites lirata Conrad, 1842, Jour. Acad. Nat. Sci. Phila., vol. viii, p. 250, pl. xv, fig. 7.

Nucula lirata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 3.

Nucula lirata Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 316, pl. xlv, figs. 5, 11, 15, 17-22, 24, 25; pl. xciii, fig. 5.

Nucula lirata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 462.

Nucula lirata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 395, fig. 503d.

Description.—"Shell of medium size, ovate-triangular; length from one-third to one-fourth greater than the height; basal margin regularly curving, more abruptly rounded at the posterior extremity; cardinal margin slightly arcuate, gradually sloping toward the posterior; anterior end short, subtruncate, usually abruptly rounded. Valves very gibbous, ventricose in the umbonal region; beaks, at the anterior third or fourth of the length of the shell, distant, elevated, rising considerably above the hinge-line; umbo very prominent. Test thick, marked by regular, strong, subangular concentric undulations, which are crossed by extremely fine radiating striae." Hall, 1885.

This species is represented by but few specimens in Maryland; but one from the bank of Evitts Creek below Wolfe Mill, has the shape of this species; its heavy concentric undulations, part of which show fine concentric striae on their surface; while the best preserved portions of the shell show the very fine radiating striae. There are internal impressions from western Maryland and Pattersons Creek, West Virginia, which apparently belong to this species. The complete impression is much thicker than that of *N. bellistriata,* and the muscular impressions although larger are smooth and scarcely so prominent. It is difficult to determine whether these internal impressions belong to *N. lirata* or *N. randalli* and one was sent to Dr. Grabau who wrote "I should prefer *N. lirata* but it is very difficult to decide. The form agrees better with that species." It is to be remembered, however, that Hall figured a much larger and more gibbous specimen than any of these, which is given as *N.*

randalli from Cumberland,[1] and this specimen is represented as having smooth muscular impressions while fig. 25 of the same plate represents an internal impression of *N. lirata* with striated posterior muscular impressions. This species is readily distinguished from the associated ones by the strong concentric undulations and fine radiating striae.

Length, 15 mm.; height, 11 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

NUCULA VARICOSA Hall

Plate XXV, Figs. 11-16

Nucula varicosa Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 2.
Nucula varicosa Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 319, pl. xlvi, figs. 12-23; pl. xciii, fig. 4.
Nucula varicosa Clarke, 1903, N. Y. State Mus., Bull. 65, p. 463.

Description.—Shell of medium size, ovate-triangular; length somewhat greater than the height; basal margin curving, more abruptly rounded posteriorly; post-cardinal margin arcuate or subtruncate; anterior end very short and abruptly rounded below. Valves gibbous, ventricose in the umbonal region. Beaks subanterior, prominent, incurved, arching over the hinge-line. Umbonal slope narrowly rounded, arching upward and extending from the beaks to the post-basal extremity; post-cardinal slope narrow. Test strong, marked by fine, irregular, concentric striae, and by numerous varices of growth, which are closely arranged on the marginal portions of the shell. Hinge strong, and posterior to the beaks it is marked by a narrow row of very fine transverse teeth. Specimens vary in length from 15-18 mm.; and in height from 12-16 mm. Hall, 1885, condensed.

The varices of these specimens are not quite so strong as on the type specimens of this species nor the beaks as high, yet they are higher than

[1] Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, explanation figures 26 and 27 of plate 45.

in *N. bellistriata.* On comparison with specimens of *N. varicosa* in the office of the New York State Paleontologist they were found to be very similar and therefore are referred to this species. This species is closely related to *N. bellistriata* (Con.); but is distinguished by its more erect and triangular form, higher beaks, finer concentric striae and numerous strong varices of growth.

Length, 14-18 mm.; height, 11-13 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; and from another place in western Maryland the exact locality of which is not stated; on the Romney-Hanging Rock Road about ½ mile north of Romney, W. Va. (?).

Collections.—Maryland Geological Survey; New York State Museum.

Genus NUCULITES Conrad

NUCULITES OBLONGATUS Conrad

Plate XXV, Figs. 17-20

Nuculites oblongatus Conrad, 1841, Geol. Surv. N. Y., An. Rep., p. 50, plate, fig. 8.
Nuculites oblongatus Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 4.
Nuculites oblongatus Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 324, pl. xlvii, figs. 1-12.
Nuculites oblongatus Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Nuculites oblongatus Clarke, 1903. N. Y. State Mus., Bull. 65, p. 465.
Nuculites oblongatus Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 398, figs. 509a-c.

Description.—Shell large, elongate ovate, widest at the anterior end; length usually more than twice the height; basal margin nearly straight, sometimes gently arcuate; posterior extremity abruptly rounded; cardinal line slightly oblique, gently arcuate; anterior end short and rounded and in the inside is a strong vertical clavicular ridge just anterior to the beaks which extends for more than half the height of the shell and in the internal impressions is represented by a strong furrow. Valves depressed-convex in the lower and posterior portions, more convex on the anterior end and in the umbonal region; beaks at about the anterior fourth, appressed, not rising above the hinge-line; umbonal slope broadly rounded and undefined. Test thick in the upper part of the shell; surface marked

by very fine concentric striae, which are sometimes slightly fasciculate on the lower portion of the shell; hinge furnished with numerous transverse teeth.

This species is common in the Hamilton shales of Maryland and is represented by various forms from the short young specimens up to the adult ones of normal size and shape as well as by some very elongated specimens due to crushing. Hall reported this species from the Hamilton formation at Pattersons Creek, [W.] Va. (Pal. N. Y., vol v, pt. i, Lamellibranchiata, ii, p. 325) and on pl. xlvii, figs. 7, 11 and 12 are stated to be from the Hamilton group, near Cumberland, Md. This species is readily recognized from its elongate ovate outline, widest at the anterior end, and by the strong vertical clavicle in the interior of the shell or its impression in the internal mould.

Length, 10-23 mm.; height, 5-11 mm. One elongated specimen is 33 mm. in length.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; Williams Road ¼ mile east of Queen City Hotel, Cumberland; on National Road ½ mile west of Tonoloway Ridge; on Oldtown Road east of Maryland Ave., Cumberland; McCoys Ferry; southwest of McCoys Ferry; Ernstville; on National Road northeast of Cumberland; along Flintstone Creek in Gilpin; west of iron bridge over Town Creek northeast of Oldtown; W. Va. side Potomac River 4 miles south of Cumberland; hill 3 miles south of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

NUCULITES TRIQUETER Conrad

Plate XXVI, Figs. 1-5

Nuculites triqueter Conrad, 1841, Geol. Surv. N. Y., An. Rep., p. 50.
Nuculites triqueter Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 4.
Nuculites triqueter Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata, ii, p. 326, pl. xlvii, figs. 17-28; pl. xciii, figs. 8-10.
Nuculites triqueter Clarke, 1903, N. Y. State Mus., Bull. 65, p. 466.
Nuculites triqueter Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 398, figs. 509d-f.

Description.—Shell of medium size, or larger, trigonal, short; length greater than the height; basal margin regularly curving, sometimes straight on the posterior portion, abruptly rounded at both extremities; posterior margin obliquely truncate; anterior end short, rounded; cardinal margin arcuate. Valves convex, gibbous in the middle and above; beaks at the anterior third or fourth, very prominent, incurved, arching over the hinge; umbo prominent and gibbous; umbonal ridge distinct, subangular, extending from the beak to the post-inferior extremity; post-cardinal slope short, descending abruptly from the angular umbonal ridge to the obliquely truncate posterior margin. Test thin, marked by very fine concentric striae; hinge comparatively short, furnished with more than twenty small teeth, which are continued in a row under the beaks without interruption; muscular scars faintly marked; clavicular ridge very strong, sharply defined and curved.

This species is common in the bluish somewhat arenaceous Hamilton shales of Maryland and West Virginia in which the various forms have been obtained. It was reported by Hall from the Hamilton group "at Pattersons Creek, [W.] Virginia" (Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 327) and on pl. xlvii a cast of the left valve is figured from the Hamilton group at Cumberland, Md. This is a very clearly defined species and is readily recognized from its short trigonal outline; obliquely truncate posterior margin and short abrupt post-cardinal slope; subangular, distinct umbonal ridge; and by the strong, sharply-defined and curved clavicular ridge which in the internal impressions is represented by the conspicuous, deep and curved furrow.

Length, 9½-16 mm.; height, 8-14 mm.; depth, 4-11 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; W. Va. Cent. R. R. cut at 21st Bridge; B. & O. R. R. cut at 21st Bridge; Williams Road 3½ miles southeast of Cumberland; McCoys Ferry; southwest of McCoys Ferry; along Flintstone Creek in Gilpin; W. Va. side Potomac River 3 and 4 miles south of Cumberland; hill about 3 miles south of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

NUCULITES GRABAUI n. sp.

Plate XXVI, Fig. 6

Description.—Shell rather less than medium size, cuneiform, widest along line extending from beak to basal margin, pointed posteriorly; length considerably less than twice the height; anterior end of shell rounded, basal margin and cardinal line of posterior part of shell strongly inclined toward each other so that the posterior half of the shell is decidedly pointed. Valve depressed-convex in the lower and posterior portions and only moderately convex in the umbonal region; beak subcentral, six mm. from the anterior and nine mm. from the posterior extremity; just anterior to the beak is a broad and prominent clavicular ridge which extends two-thirds of the distance across the shell, curving slightly toward the anterior end.

The above description was based upon a single internal impression of a right valve from McCoys Ferry and consequently nothing is known regarding the surface markings of the species. Its more nearly central beak and pointed posterior end separate it from *N. oblongatus;* while its flatness, lack of angular umbonal ridge and more central beak distinguish it from *N. cuneiformis.* The writer hesitated to describe this specimen as a new species therefore consulted Dr. Grabau who wrote as follows: "Why not a new species? Its beak is too central to agree with *N. oblongatus* and of course you have not much more to go on. Still I think you are safe in giving it a new specific name." In view of the above statement it is described as a new species and named in honor of Dr. Grabau. Later, additional specimens were found southwest of McCoys Ferry.

Length, 16 mm.; height, $9\frac{1}{2}$ mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry; southwest of McCoys Ferry.

Collection.—Maryland Geological Survey.

NUCULITES MODULATUS Kindle

Plate XXVI, Figs. 7, 8

Nuculites modulatus **Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 89, pl. vii, figs. 13, 14.**

Description.—Shell elongate, oval, length usually about two-thirds the width. Cardinal lines nearly straight or slightly arcuate. Basal margin regularly arcuate, anterior and posterior margins broadly rounded. A nearly vertical clavicle extends from the hinge-line just anterior to the beaks two-thirds the distance to the basal margin. Valves moderately convex in the umbonal region, less convex in the lower and posterior portions. Beaks anteriorly placed, appressed and not rising above the hinge-line. Umbonal slope undefined and broadly rounded blending with the depressed posterior border. Transverse teeth slightly arched, with the crest toward the beak. Surface marked by fine concentric striae. Three specimens measure respectively 7, 8, and 8 mm. in length, and 11, 14 and 13 mm. in height. This species is rather closely allied to *Nuculites oblongus* from the Hamilton. It is distinguished from this shell, however, by the greater proportional width, the broader, more regularly rounded, posterior margin, and the less pronounced umbonal slope.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Family LEDIDAE

Genus PALAEONEILO Hall

PALAEONEILO CONSTRICTA (Conrad)

Plate XXVI, Figs. 9-12

Nuculites constricta Conrad, 1842, Jour. Acad. Nat. Sci. Phila., vol. viii, p. 249, pl. xv, fig. 8.

Nucula bellatula Hall, 1843, Geol. N. Y., pt. iv, p. 197, fig. 7 on p. 196.

Palaeoneilo constricta Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 7.

Palaeoneilo constricta Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 333, pl. xlviii, figs. 1-16; pl. li, fig. 17.

Palaeoneilo constricta Clarke, 1903, N. Y. State Mus., Bull. 65, p. 474.

Palaeoneilo constricta Clarke, 1904, N. Y. State Mus., Mem. 6, pt. 2, p. 311, pl. xv, figs. 9-13.

Palaenoeilo constricta Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 400, figs. 510a, b.

Description.—Shell of medium size or smaller; ovate-cuneate, subnasute behind; proportions of length and height variable but the length usually about one-third greater; basal margin rounded in the middle and at anterior end, straight or slightly constricted toward the posterior end; anterior end abruptly rounded; posterior extremity contracted, cuneate or subnasute, constricted below; cardinal line abruptly declining anterior to the beak, and more gently declining to the posterior. Valves convex below and posteriorly, becoming gibbous above the middle and in the umbonal region; beaks at about the anterior third, prominent, rising above the hinge-line; umbonal ridge rounded, not strongly defined, with a depression or undefined furrow below it, which extends from immediately posterior to the beak to the post-inferior margin. Surface, in well preserved specimens, marked by fine, regular and even, thread-like striae, which frequently become obsolescent in the furrow and on the post-cardinal slope; hinge marked by numerous crenulations, which are coarser toward the anterior and posterior extremities.

A considerable number of well preserved, typical specimens of this species were obtained in the bluish finely arenaceous shales of the Hamilton beds in Maryland. This species was also identified by Hall from the Hamilton group of "Pattersons Creek, [W.] Va." (Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 334) while figures 9 and 14 of plate xlviii are stated to be from the Hamilton group, near Cumberland, Md. This species is readily identified by its constricted and projecting posterior end, its form, and fine, regular, even, thread-like striae which are much fainter or obsolete on the posterior part of the shell.

E. M. Kindle makes the following statement concerning specimens found in the Onondaga member:

> A *Palaeoneilo* having apparently most of the essential characters of *P. constricta* occurs in the same bed with numerous specimens of *Chonetes mucronatus*. It has the constricted postero-basal margin of that species and fine concentric striae but is rather more gibbous in the umbonal region than ordinary examples of *P. constricta*.

Length, 13-17 mm.; height, 9-11 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland. HAMILTON MEMBER. East

bank Evitts Creek below Wolfe Mill; Williams Road 1/4 mile east of Queen City Hotel, Cumberland; B. & O. R. R. cut at 21st Bridge; Williams Road 3½ miles southeast of Cumberland; McCoys Ferry; southwest of McCoys Ferry; on National Road northeast of Cumberland; on the Romney-Hanging Rock Road about ½ mile north of Romney, W. Va.; 1 mile north of Romney, W. Va.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

PALAEONEILO PLANA Hall

Plate XXVI, Figs. 13-15

Palaeoneilo plana Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 7.
Palaeoneilo plana Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 334, pl. xlviii, figs. 21-28.
Palaeoneilo plana Clarke, 1903, N. Y. State Mus., Bull. 65, p. 478.
Palaeoneilo plana Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 399, fig. 510f.

Description.—"Shell below the medium size, transversely elliptical, compressed, elongate and somewhat pointed behind; length almost twice the height; basal margin regularly and gently rounded, with a slight and undefined constriction near the posterior end which is acutely rounded; anterior end regularly rounded; cardinal line declining on each side of the beak. Valves depressed-convex; beaks anterior to the center, small, rising but little above the hinge-line; umbonal slope not defined, obscurely indicated by an undefined depression, which scarcely constricts the margin. Surface marked by very fine concentric striae, which are often obscure or obsolete." Hall, 1885.

Several specimens of a small *Palaeoneilo* were found in rather thin blue shales which agree fairly well with the above description and are referred to this species. Part of the specimens are smaller than the type ones of *P. plana* but agree closely with the outlines and proportions of that species. One specimen resembles very closely fig. 21, pl. xlviii, Lamellibranchiata ii, pt. i, vol. v, Pal. N. Y., with the exception of the posterior constriction which is slightly stronger than in this species and in this character something like *P. constricta*. The species is closely related to

P. constricta Hall but as stated by Hall it is distinguished by its delicate texture, smaller size, more elongate form, and more central beaks.

Length, of the smaller specimens, 11 mm.; height, 6 mm.

A larger specimen which is referred to this species is 22 mm. in length and 12 mm. in height.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; W. Va. side Potomac River about 3 miles south of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

PALAEONEILO MAXIMA (Conrad) (?)

Plate XXVI, Fig. 16

Nuculites maxima Conrad, 1841, Geol. Surv. N. Y., An. Rep., p. 50.
Tellina (?) *ovata* Hall, 1843, Geol. N. Y., pt. iv, p. 196, fig. 6.
Palaeoneila maxima Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 9.
Palaeoneilo maxima Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 335, pl. xlviii, figs. 29-38.

Description.—"Shell large, ovate-acute; length one-half greater than the height; basal margin very convex in the middle, curving regularly to the anterior end; posterior extremity narrow and abruptly rounded, or subtruncate at the termination; anterior end somewhat narrowly rounded; cardinal line declining rapidly on either side of the beak. Valves regularly convex below, becoming gibbous in the middle and above; beaks anterior to the center, prominent, small, with the apices very slightly incurved; umbonal ridge distinct, subangular, extending to the upper side of the posterior extremity; the furrow below is broad, obscure and undefined. Surface marked by fine concentric striae, which are often very obscure or obsolescent." Hall, 1885.

A left valve of this species was obtained from the blue shales of Evitts Creek below Wolfe Mill, which agrees closely with the above description; but the posterior constriction is rather sharper than on specimens of this species in the office of the N. Y. State Paleontologist. The specimen was shown Dr. J. M. Clarke who suggests that it be compared with both *P.*

maxima and *P. constricta*. Dr. Grabau refers it to *P. maxima* (?). Observing that "the sulcus is a trifle stronger than usual in this species and more like that of *P. constricta*." The species is characterized by its size, very gibbous form, abruptly contracted posterior end and rather obscure concentric striae.

Length, 24 mm.; height, 15 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Evitts Creek below Wolfe Mill.

Collection.—Maryland Geological Survey.

PALAEONEILO FECUNDA Hall

Plate XXVI, Figs. 18-21

Palaeoneilo fecunda Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 8.
Palaeoneilo fecunda Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 336, pl. xlix, figs. 13, 15-24.
Palaeoneilo fecunda Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Palaeoneilo fecunda Clarke, 1903, N. Y. State Mus., Bull. 65, p. 476.
Palaeoneilo fecunda Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 399, figs. 510k, l.

Description.—"Shell large, elongate-ovate; length nearly twice the height; basal margin broadly curving; posterior end obtusely rounded or doubly truncate; anterior end regularly rounded; cardinal line arcuate. Valves regularly convex below, gibbous above and in the umbonal region; beaks at less than the anterior third from the end, moderately elevated above the hinge-line; umbonal slope flattened, giving a slight angularity to the shell above and below it, and an oblique truncation to the posterior extremity. Test thick, marked in the anterior portion by fine, regular concentric striae, some of which become elevated into sharp, lamelliform striae, with finer intermediate ones on the posterior half of the shell." Hall, 1885.

A left valve of this species was found on the Williams Road one-fourth mile east of the Queen City Hotel and Hall figured several specimens from the Hamilton group, near Cumberland, Md. (Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, pl. xlix, figs. 18-24) and also reported it from Hardy County [W.] Virginia (*ibid.*, p. 337). The specimen repre-

sented by fig. 18 on pl. xlix from the vicinity of Cumberland is rather shorter than the majority of specimens of this species and it is almost of the same size and proportions as the Williams Road specimen. This species is closely related to *P. tenuistriata* Hall and *P. muta* Hall but is separated by its fine concentric striae, some of which become elevated into sharp lamellae, with finer intermediate ones on the posterior part of the shell. The striae of *P. tenuistriata* as compared with *P. fecunda* are finer and more irregular becoming crowded together on the posterior part of the shell, while in *P. muta* the strong, lamellose striae extend from the posterior to the anterior margin of the shell.

Length, 25 mm.; height, 16 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road ¼ mile east of Queen City Hotel, Cumberland.

Collections.—Maryland Geological Survey; New York State Museum.

PALAEONEILO PERPLANA VAR. GRABAUI n. var.

Plate XXVI, Figs. 22, 23

Description.—Shell rather large, length less than twice the height; basal margin curving; umbonal slope marked by two ridges separated by a conspicuous sulcus. Entire surface marked with regular, strong, elevated lamellae extending from the anterior to the posterior extremities, between which are fine striae.

The specimen upon which the above description is based is an external impression of a right valve which is broken and somewhat imperfectly preserved. It differs clearly from *P. perplana* in the conspicuous lamellae extending entirely across the shell from its anterior to the posterior end while in that species they "are usually obsolete, except on the posterior portion of the shell."[1] Neither does it agree any more closely with any other species. Professor Grabau who examined the specimen wrote me as follows: "It comes nearest to *P. perplana* of the New York beds, but is more rugose and has a somewhat deeper umbonal channel, though I think much of the apparent depth of this is due to crushing. It would

[1] Hall, Lamellibranchiata ii, p. 339.

seem to me like an accelerated derivative from *perplana* in which the adult coarse concentric lamellae of *P. perplana* appear early and become accentuated by the time adult conditions are reached in this specimen. I think you are safe in giving it a varietal name. It corresponds closely with no species I know."

Length, 23½ mm.; height, 15½ mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Evitts Creek below Wolfe Mill.

Collection.—Maryland Geological Survey.

PALAEONEILO EMARGINATA (Conrad)

Plate XXVII, Figs. 1-6

Nuculites emarginata **Conrad, 1841, Geol. Surv. N. Y., An. Rep., p. 50.**
Palaeoneilo emarginata **Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 7.**
Palaeoneilo emarginata **Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 338, pl. l, figs. 1-11.**
Palaeoneilo emarginata **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 475.**
Palaeoneilo emarginata **Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 400, figs. 510m-p.**

Description.—" Shell of medium size or larger, subelliptical; length usually more than twice the height; basal margin gently curving or nearly straight from the post-inferior angle to the anterior end, where it is more abruptly rounded; posterior margin deeply sinuate; anterior end regularly and somewhat abruptly rounded; cardinal line gently arcuate. Valves regularly convex in the lower anterior half, becoming gibbous above; beaks at a little less than the anterior third from the end; umbonal slope marked by a strong elevation or ridge, with a depression above it, which produces a marked emargination; the post-cardinal extremity, above this, is produced into a linguiform extension, which is sometimes angular, but usually abruptly rounded at the termination. Surface marked by strong, elevated, distant, lamellose, concentric ridges, extending the entire length of the shell, between which are very fine concentric striae; the intermediate striae become obscure or obsolete, according to the degree of weathering and nature of the matrix." Hall, 1885.

A considerable number of specimens of this species were obtained from the Hamilton shales of Maryland. Hall identified the species from the Hamilton group, near Cumberland, Md. (Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 339) and the Maryland specimens agree fully with the figures of the New York specimens. This is a sharply differentiated species and is distinguished by its deeply emarginate posterior margin; strong, elevated, distant, lamelliform concentric striae, with finer striae between; strong umbonal ridge, with depression above it and broad conspicuously marked sinus below.

Length, 16-20 mm.; height, 7-11 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; Williams Road ¾ mile east of Queen City Hotel, Cumberland; Williams Road ½ mile east of Queen City Hotel, Cumberland; B. & O. R. R. cut at 21st Bridge; McCoys Ferry; southwest of McCoys Ferry.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

PALAEONEILO TENUISTRIATA Hall (?)

Plate XXVII, Fig. 7

Palaeoneilo tenuistriata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 9.
Palaeoneilo tenuistriata Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 336, pl. xlix, figs. 1-12, 14, pl. xciii, fig. 13.
Palaeoneilo tenuistriata Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Palaeoneilo tenuistriata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 479.
Palaeoneilo tenuistriata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 399, fig. 510c.

Description.—Shell large, ovate-elliptical; length more than one-third greater than the height; basal margin regularly curving; posterior end doubly truncate; cardinal line gently arcuate; anterior end short, rounded. Valves convex, gibbous above the middle and in the umbonal region; beaks at about the anterior third, moderately prominent, nearly straight, little elevated above the hinge-line; the posterior end of the shell is depressed-convex, with a more or less distinct depression extending to the post-inferior extremity from just posterior to the beaks, giving a trunca-

tion and slight constriction of the margin. Test thick, especially in the dorsal region; surface marked by very fine concentric striae, which are often crowded together on the basal and posterior portions of the shell, forming irregular undulations of growth; in some well-preserved specimens the concentric striae are elevated into sharp lamellae. A specimen of average size has apparently about the following dimensions: length, 33 mm. and height, 19 mm.

The Maryland Collection contains a rather imperfect and worn specimen which is referred with some hesitation to this species. The length in comparison with the height is less than that in normal specimens of *P. tenuistriata;* but it shows similar fine concentric striae with heavier lines of growth toward the margin and the general appearance is quite near that of the larger forms of this species. The specimen was examined by Dr. Grabau who wrote as follows: "Agrees well with *P. constricta* in anterior position of beak but does not agree absolutely with any of the New York types. Except for the less proportional length it would agree fairly well with *P. tenuistriata.* Should be tempted to call it a short variety of that species."

Another specimen of what appears to be a large *Palaeoneilo* from Evitts Creek is referred with doubt to this species. Dr. Grabau examined the specimen and wrote "*P. tenuistriata* perhaps. It has outline more of *Elymella* cf. *nuculoides* Hall and sulcus is weak, this may be due to pressure however." It is to be remembered that Hall figured a specimen of this species from "near Cumberland, Md.," and also reported it from "Pattersons Creek, [W.] Va."[1]

Length of specimen from McCoys Ferry, 32 + mm.; height, 23 mm.

Length of specimen from Evitts Creek, 40 mm.; height, 27 mm.

Occurence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry; southwest of McCoys Ferry; east bank Evitts Creek below Wolfe Mill; B. & O. R. R. cut at 21st Bridge; W. Va. side Potomac River about 3 miles south of Cumberland.

Collection.—Maryland Geological Survey.

[1] Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 336, and pl. xlix, explanation figs. 12, 14.

PALAEONEILO CLARKEI n. sp.

Plate XXVII, Figs. 10-13

Description.—Shell large, elongate-ovate; length somewhat less than twice the height; basal margin nearly straight or slightly concave near the middle. Anterior end rounded; posterior end truncate to slightly rounded. Valves convex, the greatest convexity along the middle line and near the umbo; the left valve crossed by a shallow sinus which extends obliquely from the umbo about to the middle of the basal margin, apparently not so conspicuous on the right valve; beaks at about the anterior third. Test thin, and apparently marked with medium sized concentric striae which extend from the anterior to the posterior end. Hinge marked by numerous crenulations or taxodont teeth, which are coarser toward the posterior extiemity.

The specimens are more or less completely exfoliated so that it is difficult to describe their surface characters. The species is distinguished by its elongate form, striae and shallow sinus.

Length, 30-34 mm.; height, 16-19 mm.

Named in honor of Dr. John M. Clarke.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. W. Va. side Potomac River about 3 miles south of Cumberland.

Collection.—Maryland Geological Survey.

PALAEONEILO ROWEI n. sp.

Plate XXVII, Figs. 14, 15

Description.—Shell large, elongate-ovate and very gibbous in the umbonal region; length considerably less than twice the height; basal margin curving and anterior end rounded. Valve strongly convex especially toward the umbo; beak prominent and near the anterior end. Surface markings unknown. Anterior and posterior muscular impressions strongly marked, hinge marked by numerous crenulations apparently of about equal strength.

The above description is based upon an internal impression of a left valve from the National Road ½ mile west of Tonoloway Ridge; but the

shape, position of beak and great convexity in the umbonal region apparently separate it from other species. Later, additional specimens were found at other localities.

Length, 24 mm.; height, 16 mm.

Named in honor of the late Dr. R. B. Rowe whose field work contributed greatly to the exact knowledge of the Maryland Paleozoic.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry; on National Road ½ mile west of Tonoloway Ridge; on Hancock-Harrisonville Road about 2 miles north of Hancock.

Collection.—Maryland Geological Survey.

PALAEONEILO MARYLANDICA n. sp.

Plate XXVII, Fig. 16

Description.—Shell medium size and extremely elongated; length more than twice the height; basal margin convex below the umbonal slope, rounded toward the anterior end and gradually tapering toward the posterior extremity. Right valve convex especially along the umbonal slope, anterior end rounded, posterior part tapering to almost a point and crossed by a very slight depression; beaks well anterior; left valve of specimen distorted and broken. Surface apparently marked by fine, concentric striae and occasional stronger ones, especially toward the margin.

This specimen is much more elongate than any species of *Palaeoneilo* with which the writer is acquainted, a form that is not considered due to distortion by pressure.

Length, 35 mm.; height, about 15 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. On Hancock-Harrisonville Road about 2 miles north of Hancock.

Collection.—Maryland Geological Survey.

Genus TANCREDIOPSIS Beushausen

TANCREDIOPSIS CLARKEI n. sp.

Plate XXVIII, Figs. 1, 2

Description.—Shell above medium size; length more than twice the height, beak posterior to the middle and conspicuous; portion of shell

anterior to the beak longer, larger and higher than the posterior part; hinge and ventral margins of anterior part subparallel and anterior end conspicuously rounded; posterior part of shell contracts rapidly from the beak toward that extremity which is obliquely truncate; well defined, angular ridge extends from the beak to the post-basal extremity and the shell slopes rather rapidly from it to the hinge-line; valve moderately convex which is most marked in middle part. Surface marked by rather coarse, clearly defined concentric striae which after crossing the umbonal ridge continue to the hinge-line parallel to the posterior margin.

Only a single external impression of a right valve is contained in the Maryland Collection, but this is quite well preserved. It is somewhat similar to *Ctenodonta* (*Tancrediopsis*) *subcontracta* Beushausen,[1] from the Lower and Middle Devonian of the Rhine. The similarity at least is so marked that is very evident it may be referred to this subgenus of Beushausen. In Beushausen's work *Ctenodonta* is a genus comprising a large number of species under which *Palaeoneilo* Hall emend., *Tancrediopsis* and others appear as subgenera. In the writer's opinion *Palaeoneilo* is clearly entitled to generic rank and he would raise *Tancrediopsis* to the same position. In regard to the orienting of the shell, as to which end shall be called anterior and which posterior, Beushausen's description of *C. subcontracta* and Hall's of a similar shell *Tellinomya* = *Ctenodonta nasuta*[2] supplemented by Salter's later account[3] have been followed.

The specific name is given in honor of Dr. J. M. Clarke.

Length, 28 mm.; height, $11\frac{1}{2}$ mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Western Maryland.

Collection.—Maryland Geological Survey.

[1] Abhand. d. Kön. Preuss. geol. Landesanstalt, N. F., Heft 17, 1895, p. 94; Atlas pl. viii, figs. 14-16.

[2] Pal. N. Y., vol. i, 1847, p. 152.

[3] Geol. Surv. Canada, Figs. and desc. Canadian Org. remains, Dec. 1, 1859, p. 36, pl. 8, figs. 1, 2.

Genus LEDA Schumacher

LEDA DIVERSA Hall

Plate XXVIII, Figs. 3, 4

Leda (Nuculana) diversa Hall, 1883, Pal. N. Y., vol. v, pt. i, plates and explanations, pl. xlvii, figs. 31-37.

Leda diversa Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 329, pl. xlvii, figs. 31-37.

Leda diversa Clarke, 1903, N. Y. State Mus., Bull. 65, p. 406.

Leda diversa Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 401, fig. 511c.

Description.—"Shell small, ovate-cuneate; length about twice the height; basal margin curving in the anterior portion, becoming straight or nearly so, behind; posterior extremity acuminate; anterior end proportionately large, declining rapidly from the beak and regularly rounded below. Valves gibbous in the anterior and umbonal regions, attenuated behind; beaks at about the anterior third, prominent, incurved, rising above the hinge-line; umbo prominent; umbonal ridge subangular, extending from the beaks to the posterior extremity, the surface sloping abruptly from this ridge to the hinge-line. Surface marked by fine, regular, concentric striae which are merged into the umbonal ridge and are obsolete on the cardinal slope." Hall, 1885.

An exfoliated left valve, apparently of this species, was found at McCoys Ferry; no evidence of the striae remains, but the form and proportions are those of this species.

Length, 12 mm.; height, $5\frac{1}{2}$ mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry; southwest of McCoys Ferry.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

LEDA ROSTELLATA (Conrad)

Plate XXVIII, Figs. 5-7

Nuculites rostellata Conrad, 1841, Geol. Surv. N. Y., An. Rep., p. 50.

Leda (?) rostellata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 5.

Leda rostellata Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 330, pl. xlvii, figs. 42-47.

Leda rostellata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 407.
Leda rostellata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 401, fig. 511d.

Description.—"Shell small, falciform; length more than twice the height; basal margin gently curving from the posterior extremity, more rapidly curving anteriorly; posterior end attenuate, arching upward, with the extremity narrowly rounded or subtruncate; anterior end comparatively short, abruptly rounded; cardinal line oblique, declining posteriorly, and regularly curved. Valves convex, somewhat gibbous in the umbonal region, depressed-convex posteriorly; beaks between the anterior third and fourth of the length of the shell; umbonal ridge distinctly defined, sharply angular above. Surface marked by fine, regular, equal, sharp concentric striae, which converge upon the posterior end of the shell, cross the umbonal angle, and are obsolescent on the post-cardinal slope; hinge crenulated with minute teeth which extend half the distance from the beak to the posterior end." Hall, 1885.

On the National Road west of Tonoloway Ridge a broken right valve of what is considered a young specimen of this species was found. Although the posterior end is wanting, still it apparently is of falciform shape and the surface is marked by very fine, sharp concentric striae, which are finer and more regular than those of *L. diversa*. Later, additional specimens were found at other localities.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge; in Jennings Run ½ mile west of Corriganville (?); on National Road ½ mile west of Tonoloway Ridge.

Collections.—Maryland Geological Survey; New York State Museum.

Superfamily ARCACEA

Family PARALLELODONTIDAE

Genus PARALLELODON Meek

PARALLELODON HAMILTONIAE (Hall)

Plate XXVIII, Figs. 8-12

Macrodon hamiltoniae Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 13.
Macrodon hamiltoniae Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 349, pl. ii, figs. 1-7, 9, 10.

Parallelodon hamiltoniae **Cleland, 1903, Bull. U. S. Geol. Surv., No. 206, p. 65.**
Macrodon hamiltoniae **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 437.**
Parallelodon hamiltoniae **Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 403, figs. 517b, c.**

Description.—"Shell of medium size or larger, subelliptical or subovate, wider behind; length about twice the height; basal margin broadly curving, sometimes nearly straight in the anterior portion; posterior extremity broadly rounded; sometimes subtruncate in the upper half; anterior end abruptly rounded or subtruncate; cardinal line essentially straight, obtusely subangular at both extremities. Valves convex in the posterior portion and gibbous in the anterior and umbonal portions; beaks subanterior, prominent, rising above the hinge-line. Surface marked by regular, subequidistant, lamellose, concentric lines and by fine radiating striae, which are usually interrupted at the edges of the lamellae and become thickened at their lower extension; the radii are stronger on the posterior part of the shell." Hall, 1885.

This species is represented by a considerable number of specimens in the rather coarse Hamilton shales of Maryland and shows all the characteristic features. It was also reported by Hall "from the Hamilton group, near Cumberland, Md." (Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 350) and a left valve of a large individual from near Cumberland represented by figure 10 on plate li. The most marked characters of the species are the nearly straight hinge-line with the subangular ends; rounded posterior end; strong, distant lamellose concentric lines; and fine interrupted radii, which are strongest on the posterior part of the shell.

Length, 17-24 mm.; height, 9-13 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; on Hancock-Harrisonville Road about 2 miles north of Hancock; Ernstville; along Flintstone Creek in Gilpin.

Collections.—Maryland Geological Survey; American Museum of Natural History.

Superfamily PTERIACEA

Family PTERINEIDAE

Genus PTERINEA Goldfuss

PTERINEA FLABELLUM (Conrad)

Plate XXIX, Figs. 1-4

Avicula flabella Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 238, pl. xii, fig. 8.
Avicula flabella Vanuxem, 1843, Geol. N. Y., pt. iii, p. 152, fig. 3.
Avicula flabella Rogers, 1858, Geol. Penna., vol. ii, p. 826, fig. 659.
Pterinea flabella Hall, 1884, Pal. N. Y., vol. v, pt. i, Lamellibranchiata i, p. 93, pl. xiv, figs. 1-21; pl. xv, figs. 1, 4-6, 8-10; pl. lxxxiii, figs. 11, 12.
Pterinea flabella Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Pterinea flabellum Clarke, 1903, N. Y. State Mus., Bull. 65, p. 494.
Cornellites flabella H. S. Williams, 1908, Proc. U. S. Nat. Mus., vol. xxxiv, p. 90.
Pterinea (Cornellites) flabellum Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 421, fig. 551.

Description.—Shell large; broad or narrow ovate, oblique, rarely erect; length from two-thirds to nearly equal the height. Left valve more or less convex, often gibbous and arcuate; right valve flat or concave, with a little convexity on the umbo; hinge-line straight, extended on the posterior side, and length greater than that of the valve; beak of left valve near the anterior extremity of the hinge-line and curving forward over it; umbonal region gibbous; beak of right valve depressed and not rising above the hinge; wing large, triangular, nearly flat, margin concave and extremity acute; ear of left valve a simple rounded convex lobe. Test thick; left valve marked with from six to twelve strong rounded rays, which start near the beak and continue simple to the margin; the interspaces are marked by smaller, alternating costae; there are also strong, concentric, lamellose striae of growth; in the partially exfoliated condition, and in the casts, the ears show the concentric striae and the wings evidences of the rays.

This species is common in the rather coarse arenaceous Hamilton deposits of Maryland. The specimens are nearly all exfoliated or impressions; but they show very well the most striking characters of the species;

its large size; convex left valve and flat or concave right one; large, triangular wing; small well defined ear; and strong, rounded rays on the left valve, with smaller intermediate ones.

Length parallel to hinge-line, of about an average specimen, 37 mm.; length of hinge-line, about 40 mm.; height, about 45 mm. and extreme distance from beak to base, 54 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; Town Creek Road at George Diefenbaugh's; on National Road ½ mile west of Tonoloway Ridge; on Oldtown Road, east of Maryland Ave., Cumberland; on Hancock-Harrisonville Road about 2 miles north of Hancock; on National Road northeast of Cumberland; along Flintstone Creek in Gilpin; west of iron bridge over Town Creek, northeast of Oldtown; east side Warrior Mt. east of Rush; on road about half way between Romney and Hanging Rock, W. Va. (?).

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

PTERINEA sp.

Plate XXIX, Fig. 5

***Pterinea* sp. undet. Kindle, 1912, Bull. U. S. Geol. Survey, No. 508, p. 91, pl. viii, fig. 4.**

Description.—"The collection from southwestern Virginia includes two left valves of an undetermined Peterinea. The best-preserved specimen, which is figured, though nearly flat, shows evidence of having been moderately convex in the crumpled fracture line resulting from pressure. The shell is large and erect; height and length nearly equal; margin regularly curved. Hinge-line straight, equal to or greater than the greatest length of the shell. Beak anterior; ear small, limited by a distinct sulcus; wing broad and rather sharply delimited from the rest of the shell. Surface of the valve marked by strong elevated radii which are separated by wide flat interspaces. These show a slight posterior curvature in the upper portion of their course. The ear and wing are marked by radii of much less strength than the body of the valve, but the entire

surface is cancellated by concentric striæ of equal strength, which are rather widely spaced. In outline and general appearance this shell is comparable with *P. consimilis* of the Chemung. The radii of *P. consimilis,* however, are flattened and those of this species are rounded." Kindle, 1912.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Near Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Genus LIOPTERIA Hall

LIOPTERIA cf. CONRADI Hall

Plate XXVIII, Fig. 13

Leiopteria conradi Hall, 1883, Pal. N. Y., vol. v, pt. i, plates and explanations, pl. xx, figs. 1, 2, 4.
Leiopteria conradi Hall, 1884, Pal. N. Y., vol. v, pt. i, Lamellibranchiata i, p. 159, pl. xx, figs. 1, 2, 4; pl. lxxxviii, figs. 1-4.
Liopteria conradi Clarke, 1903, N. Y. State Mus., Bull. 65, p. 426.

Description.—Shell above the medium size, subrhomboidal; length a little greater than the height; anterior margin straight, nearly vertical; basal and posterior margins regularly rounded. Valves subequally convex; the left valve somewhat more convex than the right. Hinge-line straight, longer than the length of the valve, greatly extended posteriorly. Beaks acute, directed forward, prominent, situated near the anterior end of the shell; umbonal region gibbous. Ear short, separated from the valve by a rounded depression or sulcus, extremity rounded; wing triangular, much extended, margin concave, extremity acuminate. Test, as indicated by casts or partially exfoliated specimens, marked by fine, closely arranged, concentric lines of growth, which at irregular intervals are crowded and raised into rounded or subangular fascicles, giving the surface a decidedly undulated aspect; the striae become more crowded upon the cardinal expansions, especially upon the ear.

A partially exfoliated left valve in the Maryland Collection in outline and markings resembles the above species to a considerable extent. The

concentric lines of growth are conspicuous and have a somewhat imbricating appearance in addition to which are fine concentric striae; the lines of growth and striae are very much crowded on the ear, which is perhaps a little larger than on the figured specimens of this species. The proportion of length and height of this specimen is apparently more equal than for the normal forms of the species, although perhaps the greater height is partly due to crushing.

Length and height, about 37 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. West of iron bridge over Town Creek northeast of Oldtown.

Collection.—Maryland Geological Survey.

LIOPTERIA LAEVIS Hall

Plate XXIX, Fig. 6

Leiopteria laevis Hall, 1883, Nat. Hist. New York, Paleontology, vol. v, pt. i, Lamellibr. (adv. copy), pl. xvii, figs. 5-11.

Leiopteria laevis Hall, 1884, Nat. Hist. New York, Paleontology, vol. v, pt. i, Lamellibr. 1, p. 158, pl. xvii, figs. 5-11; pl. xx, fig. 5.

Leiopteria laevis Hall, 1884, Thirty-fifth Rep. New York State Mus. Nat. Hist., p. 334.

Leiopteria laevis Cleland, 1903, Bull. U. S. Geol. Surv., No. 206, p. 67.

Leiopteria laevis Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 95, pl. viii, fig. 5.

Description.—This species is represented in the collection by a single left valve. Hall[1] described the species as follows: "Shell small, subrhomboidal; body obliquely ovate; length and height nearly equal; greatest length below the middle; margins regularly rounded, somewhat extended on the post-basal side. Left valve more convex than the right; the greatest convexity in both valves is above the middle. Hinge-line straight on the posterior side of the beak, turning abruptly down in front; entire length greater than the length of the shell. Beaks obtuse, rounded, inclined forward, situated at the anterior third of the shell, that of the left valve quite prominent. Umbonal region of left valve prominent, subtending an acute angle. Ear triangular, nearly equi-

[1] Pal. New York, vol. v, pt. i: i, 1884, pp. 158-159, pl. 17, figs. 5-11; pl. 20, fig. 5.

lateral, with a strong angular fold along the middle, separated from the body of the valve by a distinct rounded sulcus and broad byssal sinus; margin rounded; extremity obtuse. Wing triangular, flat, limited by the post-umbonal slope; margin concave; extremity acute. Test thin, marked with distinct concentric striae of growth, which are crowded and conspicuous on the wings. There are often obscure traces of radii, which are more distinct on the wing in casts or exfoliated specimens. Ligamental area narrow, with a single distinct groove. Some specimens apparently indicate the existence of an oblique lateral tooth on the posterior side of the umbo."

The writer's specimen is smaller than those described by Hall, the height of the shell being only 5 mm. and the length of the hinge-line 6 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Genus LEPTODESMA Hall

LEPTODESMA ROGERSI Hall

Plate XXIX, Figs. 7-10

Leptodesma rogersi Hall, 1883, Pal. N. Y., vol. v, pt. i, plates and explanations, pl. xxi, figs. 1-9.
Leptodesma rogersi Hall, 1884, Pal. N. Y., vol. v, pt. i, Lamellibranchiata i, p. 176, pl. xxi, figs. 1-9.
Leptodesma rogersi Clarke, 1903, N. Y. State Mus., Bull. 65, p. 419.
Leptodesma rogersi Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 426, fig. 556b.

Description.—Shell of small or medium size, subrhomboidal; body ovate, very oblique; length greater than the height; anterior and basal margins broadly rounded; posterior margin extended and abruptly recurved. Valves equally convex above; right one somewhat depressed below, comparatively higher than the left. Hinge-line straight, longer than the length of the shell. Beaks subanterior, obtuse, nearly erect, prominent, umbonal region gibbous, oblique. The anterior extremity is scarcely alate or auriculate, consisting of a rounded extension, straight

above and slightly sinuate at the base, wing comparatively large, triangular, joining the body of the valve near the posterior extremity, defined by the crowding and curving of the concentric striae; extremity prolonged into a mucronate spine which extends beyond the posterior limit of the valve. Test thin, marked by closely arranged concentric striae, which at irregular intervals are crowded into fascicles, producing a gently undulating surface; on the wing the striae are closely arranged, and just below the hinge-line are turned backward along the spiniform extension of the wing. One specimen has a length from beak to base of 24 mm., height 15 mm., hinge-line about 20 mm.; small specimens are often less than 10 mm. in length and height. (Hall, 1884, condensed.)

The external impression of a left valve occurs in the Maryland Collection which is apparently a small specimen of this species. The end of the spine is gone or else it is not as long as usual while the concentric striae are rather sharper and quite similar to those on some specimens of *L. sociale* Hall in the New York State Museum. Another specimen not so well preserved was found at the same locality which Dr. Grabau compared with *Leptodesma rogersi* calling attention, however, to the fact that the shell is less oblique than in most specimens of this species.

Length, 9 mm.; height, 6 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collection.—Maryland Geological Survey.

Family AMBONYCHIIDAE

Genus MYTILARCA Hall

MYTILARCA (PLETHOMYTILUS) OVIFORMIS (Conrad)

Plate XXIX, Figs. 11-13

Inoceramus oviformis Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 246, pl. 13, fig. 7.

Mytilarca oviformis Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 21.

Mytilarca (Plethomytilus) oviformis Hall, 1884, Pal. N. Y., vol. v, pt. i, Lamellibranchiata i, p. 255, pl. xxxi, figs. 1-8; pl. lxxxvii, fig. 8.

Mytilarca oviformis **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 457.**
Plethomytilus oviformis **Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 434, figs. 567d, e.**

Description.—" Shell large; body ovate, erect, wide posteriorly and acute above; length about one-fifth greater than the height; ventral margin for nearly half the length of the shell nearly direct, thence gently curving into the posterior extremity which is broadly rounded; dorsal margin very gently curved. Valves equal, regularly convex in the posterior part, becoming gibbous in the umbonal region; hinge-line straight, less than the height of the shell; beaks prominent, anterior acute, and incurved, rising above the cardinal line. Test thick, marked by fine, close striae of growth which at intervals are fasciculate and raised into lamellose ridges and very much crowded and elevated on the ventral side of the shell; ligamental area wide, finely striated longitudinally." Hall, 1884.

Several broken specimens were found the form of which and other characters apparently leave no doubt regarding their identity with the above species. A large specimen from western Maryland, the exact locality unknown, was sent to Dr. Grabau who wrote as follows: " I have a specimen (internal mold) of *Plethomytilus oviformis* from the Encrinal limestone of Eighteen Mile Creek [N. Y.] which is of the same size as this specimen. Placed side by side they appear to be perfectly identical, the differences being such as can easily be accounted for by the fragments broken away on your specimen." The species is well defined by its large size, ovate outline; truncate front; wide ligamental area; and beaks projecting above the cardinal line.

Length, 58 + mm.; too badly broken to determinate the height.

Length, of a smaller specimen, 45 mm.; height, 32 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; cut on B. & O. R. R. cut at 21st Bridge; along Flintstone Creek in Gilpin; western Maryland, but exact locality unknown.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Family CONOCARDIIDAE

Genus CONOCARDIUM Bronn

CONOCARDIUM NORMALE Hall

Plate XXX, Figs. 1-2

Conocardium normale Hall, 1883, Pal. N. Y., vol. v, pt. i, pl. 68, figs. 17-19.
Conocardium normale Hall, 1885, Pal. N. Y., vol. v, pt. i, 2, p. 411, pl. lxviii, figs. 17-19.

Description.—Shell large, subovate, trigonal; length about twice the height; basal margin regularly curving. Posterior extremity obliquely truncate. Cardinal line straight. Anterior end narrow, nasute. Valves ventricose, abruptly contracted anteriorly and truncate behind. Beaks posterior to the center, prominent, strongly incurved. Umbonal slope angular, continuing to the post-inferior margin. Post-cardinal slope concave. Test thick, body of the shell marked by numerous radii, between which are undulating lamellose concentric striae. When the shell is exfoliated the radii become stronger and the intermediate surface is marked by fine radiating striae. With the growth of the shell the anterior rays become greatly strengthened and semi-tubular. The cast of the foot-sheath is bilobed, and doubly pointed behind. Two specimens measure respectively 50 and 60 mm. in length, 25 and 32 mm. in height, and 26 and 30 mm. in the depth of both valves. This species bears a close resemblance to the elongate forms of *C. cuneus*. There is, however, no tendency to a duplication of the ribs, which is a common feature in the specimens from the Schoharie grit. Hall, 1885.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Near Cumberland.

Collection.—New York State Museum.

CONOCARDIUM CUMBERLANDIÆ Swartz n. sp.

Plate XXX, Figs. 3, 4

Description.—Shell small, ovate cuneate; length and height subequal. Valves gibbous in center, very abruptly contracted anteriorly; anterior extremity extended, nasute; truncate posteriorly. Beaks a little behind

center of cardinal margin; umbonal slope angular, continuing to post-inferior margin; postcardinal slope concave. Anterior and posterior extremities gaping. Surface ornamented by radial plications, which are about 1 mm. apart upon middle and anterior parts of shell 25 mm. long. Plications become obsolete near anterior extremity. They are duplicated and much closer upon postcardinal surface, where they are crossed by conspicuous fine concentric striæ. The middle and anterior part of shell is also crossed by lamellose lines of growth.

Length 20 mm.; height 20 mm.

This species closely resembles *C. cuneus* var. *nasutum* but differs in the much more abrupt constriction of its anterior end. The specimens observed are internal casts.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Little Run, east of Hancock; Williams Road, 3½ miles southeast of Cumberland.

Collection.—Maryland Geological Survey.

[C. K. Swartz.]

Family PTERIIDAE

Genus ACTINOPTERIA Hall

ACTINOPTERIA DECUSSATA Hall

Plate XXX, Figs. 5-8

Avicula decussata Hall, 1843, Geol. N. Y., pt. iv, p. 203, figs. 1, 2.

Actinopteria decussata Hall, 1884, Pal. N. Y., vol. v, pt. i, Lamellibranchiata i, p. 111, pl. xvii, figs. 24, 28; pl. xviii, figs. 1-15; pl. xx, fig. 19; pl. lxxxiv, fig. 4.

Actinopteria decussata Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.

Actinopteria decussata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 351.

Actinopteria decussata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 449. fig. 591c.

Description.—Shell large, subrhomboidal; body subovate, very oblique; length about one-fourth greater than the height; margins regularly curving, the anterior sometimes nearly vertical, the posterior more abruptly rounded. Valves convex, the right valve less convex and smaller than the left one; hinge-line straight, less than the length of the valve; beak acute, prominent, inclined forward, close to the anterior end of the shell;

umbonal region prominent, and in the left valve gibbous; ear small, separated from the valve by a broad sulcus, beyond which it is a mere fold in the shell; wing large, triangular, flat, extending nearly to the margin of the valve, limited by a somewhat distinct sulcus and the abrupt bending of the concentric striae; margin concave. Test thick; left valve marked with strong, prominent, rounded radii, regularly alternating with finer ones on the posterior half of the valve; crossed at regular intervals by strong concentric lamellae which generally interrupt the radii; on the right valve the markings are much subdued, the rays often obsolete, especially on its lower part, and the concentric lamellae are simple undulations of the surface; from maceration or exfoliation these surface characters are usually only partially preserved.

A number of rather imperfectly preserved impressions of this species were found in the rather coarse arenaceous shales and sandstones of the Maryland Hamilton. They possess the distinctive specific characters in the extreme obliquity of the body; large, triangular wing; small ear, separated from valve by broad sulcus; rounded radii, with smaller ones between, interrupted by prominent concentric lamellae. The specimens are too imperfect for satisfactory measurements.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge (?); east bank Evitts Creek below Wolfe Mill; on road east of Pine Hill about 4 miles north of Oldtown.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

ACTINOPTERIA BOYDI VAR. GIBBOSA n. var.

Plate XXX, Figs. 9, 10

Description.—Shell of medium size, with straight hinge-line and somewhat rounded anterior and front margins. Right valve moderately convex and left valve strongly convex and gibbous along the umbonal ridge; ear short and limited by a sulcus which is more sharply defined on the left valve; wing not distinctly separated from the body of the shell. Left valve marked by numerous, strong, simple rays which extend from the

umbo to the margin and are crossed by concentric somewhat elevated lamellae which are most conspicuous on the wing; on the right valve the rays occur on the wing and the posterior half of the body of the shell while the concentric lamellae are similar to those of the opposite valve.

This specimen, in general, is quite similar to certain forms of *A. boydi* except that the body of the left valve is strongly gibbous so that there is a much greater difference in the convexity of the two valves, while on the right valve the rays extend over about one-half of its body instead of being obsolete. It is thought that the marked difference in these two characters is of sufficient importance to warrant the separation of this specimen as a variety from the normal form of *A. boydi*. This opinion in the main is supported by that of Dr. Grabau who examined the specimen and stated that he would make it a new variety at least, emphasizing the difference in convexity of valves and the extension of rays on body of right valve.

Length, about 38 mm.; height, about 34 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. On Town Creek 4 miles northeast of Oldtown; Town Creek Road at Geo. Diefenbaugh's.

Collection.—Maryland Geological Survey.

ACTINOPTERIA SP.

Plate XXX, Fig. 11

Description.—Shell small and convex, the convexity of the left valve being the greater which is quite marked on its body; ear small and separated by a shallow sulcus from the body, wing not sharply separated from the body and outline unknown. The surface of the left valve shows numerous simple, fairly strong rays, with generally a finer one between two that are heavy; crossed by regular, sharp concentric lines which give a somewhat reticulated appearance to the surface. Right valve exfoliated, not showing the surface markings.

This specimen is related to *A. boydi* and is probably a new species but on account of its broken and imperfect condition it is thought better not

to name it at present. The specimen, however, has been seen by Dr. Grabau who regards it as a new species.

Length, about 28 mm.; height, about 25 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. West of iron bridge over Town Creek northeast of Oldtown.

Collection.—Maryland Geological Survey.

Family MYALINIDAE

Genus MODIELLA Hall

MODIELLA PYGMAEA (Conrad)

Plate XXXI, Figs. 1-5

Pterinea pygmaea Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 251, pl. xiii, fig. 15.

Modiella pygmaea Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 514, pl lxxvi, figs. 9-20.

Modiella pygmaea Clarke, 1903, N. Y. State Mus., Bull. 65, p. 443.

Modiella pygmaea Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 456, fig. 606d.

Description.—" Shell small, obliquely obovate; length one-third greater than the height; basal margin arcuate anterior to the middle, broadly and distinctly curving to the post-inferior extremity; posterior extremity obliquely and broadly curved; anterior end short, auriculate, limited by a depression extending from just anterior to the beak to the basal margin and producing a more or less distinct sinus. Valves very convex in the middle and upper portions of the shell; beaks subanterior, small, closely appressed and incurved; umbonal slope not distinctly limited, rather prominent, arcuate, extending to the post-inferior extremity. Surface marked by fine concentric striae, crossed by curving, radiating striae which are more distinct on the body of the shell just posterior to the sinus." Hall, 1885.

Several specimens of this species were obtained from the thinner and more argillaceous Hamilton shales of Maryland and West Virginia. There is apparently no marked difference between these southern specimens and those from the typical localities for this species in central New York. It is readily identified by its shape and size, short anterior and broader

posterior end, with a curved to obliquely truncate posterior margin; auriculate anterior margin, the ear defined by a distinct sulcus; and curved radiating striae.

Length, 10-15 mm.; height, 7-10 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road 3½ miles southeast of Cumberland; east bank Evitts Creek below Wolfe Mill; Williams Road ¼ mile east of Queen City Hotel, Cumberland; W. Va. side Potomac River about 3 miles south of Cumberland; W. Va. side Potomac River 4 miles south of Cumberland; hill 3 miles south of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Superfamily NAIADACEA

Family CARDINIIDAE

Genus NYASSA Hall

NYASSA ARGUTA Hall (?)

Plate XXXI, Fig. 6

Nyassa arguta Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 28.
Nyassa arguta Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 354, pl. liii, figs. 7-20.
Nyassa arguta Clarke, 1903, N. Y. State Mus., Bull. 65, p. 467.
Nyassa arguta Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 478, fig. 639.

Description.—Shell of medium to large size, elongate subelliptical or ovate-arcuate; length about twice the height; basal margin nearly straight, often slightly arcuate or contracted posterior to the middle, abruptly recurved at the post-inferior extremity; posterior margin curved or obliquely subtruncate; cardinal line gently arcuate; anterior end narrowed and abruptly rounded. Valves depressed below, gibbous above and in the umbonal region; beaks subanterior, small, closely appressed, rising but little above the hinge-line; umbonal ridge prominent, rounded or subangular, arcuate, extending to the post-inferior extremity; below and parallel with the ridge there is a flattening or depression of the shell ex-

tending from the beaks and producing a constriction or sinuosity in the basal margin. Test thick, marked by lamellose concentric lines of growth, without other ornamentation. The hinge is characterized by numerous small teeth or callosities beneath the beak, which appear to be without special arrangement, the posterior ones being directed backward and sometimes more elongated; lateral teeth two or three in number, parallel and extending nearly to the post-cardinal extremity; anterior muscular impression deep and strong; specimens vary in length from 21 to 52 mm. and in height from 11 to 24½ mm.

An imperfect internal impression of a left valve was obtained at McCoys Ferry which is with some hesitation referred to this species. It has a similar outline and proportions with prominent arcuate, umbonal ridge and conspicuous parallel lateral teeth; but there is a conspicuous and fairly deep furrow extending from slightly in front of the beak obliquely across the anterior part of the shell which is farther forward and more prominent than the oblique constriction crossing *N. arguta.* The furrow of this specimen is perhaps partly due to crushing. Later, additional specimens were obtained at other localities.

Length, 39 mm.; height, 19 + mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry; southwest of McCoys Ferry; on east side Warrior Mt. east of Rush.

Collection.—Maryland Geological Survey.

Superfamily PECTINACEA

Family PECTINIDAE

Genus AVICULOPECTEN McCoy[1]

AVICULOPECTEN PRINCEPS (Conrad)

Plate XXXI, Figs. 10, 11; Plate XXXII, Figs. 1, 2

Monotis princeps Conrad, 1838, An. Rep. N. Y. Geol. Surv., p. 117.
Avicula parilis Conrad, 1842, Proc. Acad. Nat. Sci. Phila., vol. viii, p. 239, pl. cxii, fig. 9.

[1] Dr. G. H. Girty has recently stated that the spelling *Aviculipecten* is the etymologically correct one (Amer. Geol., vol. xxxiii, 1894, p. 295).

Aviculopecten princeps Hall, 1884, Pal. N. Y., vol. v, pt. i, Lamellibranchiata i, p. 1, pl. i, figs. 10, 11; pl. v, figs. 18, 19, 23, 24; pl. vi, figs. 1-9; pl. xxiv, fig. 7; pl. lxxxi, figs. 13-17.
Aviculopecten princeps Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Aviculopecten princeps Clarke, 1903, N. Y. State Mus., Bull. 65, p. 365.
Aviculopecten princeps Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 487, fig. 650b.

Description.—Shell large, obliquely broad-ovate; axis inclined more than 60° to the hinge-line; length and height nearly equal; anterior margin convex. Valves depressed; left valve regularly convex; right valve nearly flat, or very moderately convex. Hinge-line straight with a length of from two-thirds to more than three-fourths the length of the shell. Beaks obtuse, rounded, anterior to the middle of the hinge. Ears large; triangular; posterior one the larger; and defined by the abrupt slope of the side of the umbo, while the anterior one is separated by a distinct sulcus; lateral margins concave, becoming convex at the hinge-line. Byssal-sinus broad, rounded, well-defined and indicated on the ear by a sulcus extending to the extremity of the beak. The right valve is flatter and proportionally broader than the left. Test thin, marked by numerous regular alternating rays, which increase in number by interstitial additions, and become broader and stronger towards the margins. These radiating ribs are crossed by very fine, sharp striae of growth. On the ears the rays are nearly obsolete, and the lines of growth are sharper and stronger than on the body of the shell. The dimensions of the shells of this species are very variable. Large individuals have a height of 80 mm. with nearly equal length, and a hinge-line of 50 mm. The gradation from this form is very gradual to those in which the height is equal to, or greater than, the length, and where the length of the hinge-line is nearly equal that of the shell. Hall, 1884, condensed.

The Maryland specimens available for study are broken and quite imperfectly preserved; but after comparison with authentic specimens of this species in the New York State Museum it is thought that they are correctly identified. A fragment of a large valve shows nicely the strong radiating rays toward the margin of the shell with smaller intercalated ones. The figured left valve from the Williams Road near Cumberland

shows well the alternation and intercalation of the rays together with their faint appearance on the ears.

Length, of medium specimen, about 30 mm.; height, about 45 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. B. & O. R. R. cut at 21st Bridge (?); Williams Road ¼ mile northeast of Queen City Hotel, Cumberland; McCoys Ferry; southwest of McCoys Ferry; on Hancock-Harrisonville Road about 2 miles north of Hancock; west of iron bridge over Town Creek northeast of Oldtown (?).

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

AVICULOPECTEN EQUILATERA (Hall)

Plate XXXII, Figs. 3, 4

Avicula equilatera Hall, 1843, Nat. Hist. N. Y. Geology, vol. iv, p. 180, text fig. 7; p. 181, table illus. 39, fig. 7.

Avicula equilatera Owen and Hall, 1847, Amer. Jour. Sci., 2d ser., vol. iii, p. 59, fig. 7 in text.

Aviculopecten equilatera Hall, 1859, 12th Rept. N. Y. State Cab. Nat. Hist., p. 89.

Avicula equilatera Lincklaen, 1861, 14th Rept. N. Y. State Cab. Nat. Hist., pl. xii, fig. 7.

Aviculopecten equilaterus Lesley, 1889, Geol. Survey Penn., Rept. P4, p. 74, 1 text fig.

Aviculopecten ? equilatera Whitfield, 1891, Annals N. Y. Acad. Sci., vol. v, p. 551, pl. xi, fig. 16.

Aviculopecten ? equilatera Whitfield, 1893, Geol. Survey Ohio, Paleontology, vol. vii, p. 445, fig. 16.

Aviculopecten equilatera Kindle, Bull. U. S. Geol. Surv., No. 508, p. 93, pl. viii, figs. 2, 3, 1912.

Description.—Shell small and slightly oblique, depressed convex. Hinge-line straight, equal to greatest length of shell. Beak nearly central on hinge-line. Anterior cardinal angle apparently mucronate; margin of shell below the cardinal line slightly sinuate and gently rounded to the posterior margin, which is nearly straight but is directed slightly backward in descending from the hinge-line to the rounded posterior margin. Surface covered with 15 to 20 strong rounded plications, which are crossed by finer concentric undulations.

The species is represented by two left valves which appear to be identical with the Marcellus species described by Hall.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Ridgeville, W. Va., and Blair County, Pa.

Collection.—U. S. National Museum.

[E. M. Kindle.]

AVICULOPECTEN sp.

Plate XXXI, Fig. 12

Description.—A species of Aviculopecten not sufficiently well preserved to permit confident identification is found in the fauna. Its finely cancellated surface suggests *A. cancellatus* of the Chemung of New York.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Hancock.

Collection.—Maryland Geological Survey.

Superfamily MYTILACEA

Family MODIOLOPSIDAE

Genus MODIOMORPHA Hall

MODIOMORPHA CONCENTRICA (Conrad)

Plate XXXII, Figs. 5-9

Pterinea concentrica Conrad, 1838, Geol. Surv., N. Y., An. Rep., p. 116.
Cypricardites concentrica Conrad, 1841, Geol. Surv. N. Y., An. Rep., p. 52.
Modiola concentrica Hall, 1843, Geol. Surv. N. Y., pt. iv, p. 196, fig. 9.
Modiomorpha concentrica Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 73.
Modiomorpha concentrica Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 275, pl. xxxiv, figs. 9, 10; pl. xxxv, figs. 1-5; pl. xxxvi, figs. 1-16 (17, 18 ?).
Modiomorpha concentrica Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Modiomorpha concentrica Clarke, 1903, N. Y. State Mus., Bull. 65, p. 448.
Modiomorpha concentrica Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 515, figs. 692d, 694d.

Description.—" Shell of medium size, ovate, extremely variable in its proportions; length less than twice the height; basal margin often nearly

straight, usually a little concave on the anterior third; posterior margin abruptly rounded below and more gently curving above; anterior end produced beyond the beaks, abruptly rounded, limited by a broad depression extending from the beak to about the anterior third of the basal margin; cardinal margin oblique in the prevailing forms, moderately arcuate. Valves moderately convex, gibbous along the umbonal slope; the point of greatest convexity is about the anterior third of the length of the shell; hinge-line extending half or more than half the length of the shell; beaks subanterior, small, appressed and directed forward; a subangular elevation of the umbonal region, usually dying out about the middle of the length of the shell. Test comparatively thick, strongly ornamented by regular concentric, rounded or subangular striae, which become lamellose and coalescing on the anterior end of the valves, where they are less prominent; anterior muscular impression strong, striated, situated just within the anterior margin; posterior impression large and shallow." Hall, 1885.

Several specimens which are referred to this species were found in the coarser arenaceous shales of the Hamilton in Maryland. Part of the specimens are internal impressions; but others are more or less exfoliated ones of the shell. On part of them the concentric striae are somewhat coarser than on most of the figured New York specimens; but others appear to agree with those from that state. This species is closely related to *M. mytiloides* (Con.); but these specimens are apparently differentiated from it by their smaller size, more arcuate form, more gibbous umbonal region and the strong, regular, concentric striae. Hall identified this species from the Hamilton shales, near Cumberland (Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 276) and figured the interior of two specimens from Cumberland (*ibid.*, pl. xxxvi, figs. 14, 16). One of the more doubtful specimens was submitted to Dr. Grabau who agreed in referring it to *M. concentrica;* as well as another specimen from western Maryland the exact locality of which is unknown.

Length, 40-60 mm.; height, 25-37 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; Williams Road 3½ miles southeast of

Cumberland (?); on Hancock-Harrisonville Road about 2 miles north of Hancock; on National Road northeast of Cumberland; along Flintstone Creek in Gilpin; on the Romney-Hanging Rock Road about ½ mile north of Romney, W. Va.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

MODIOMORPHA SUBALATA (Conrad)

Plate XXXIII, Figs. 1-6

Cypricardites subalata Conrad, 1841, Geol. Surv. N. Y., An. Rep., p. 83.
Modiomorpha subalata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 77.
Modiomorpha subalata Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 283, pl. xxxv, figs. 6, 7; pl. xxxix, figs. 1-14, 16.
Modiomorpha subalata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 453.
Modiomorpha subalata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 515, fig. 692b.

Description.—" Shell of medium size or smaller, subquadrangular, or subovate; subalate posteriorly, with the extremity obliquely truncate; length more than one-third greater than the height; basal margin straight or slightly concave on the anterior half, and thence regularly curving to the post-basal extremity; posterior margin abruptly recurved below, and continuing with a gentle curvature, or in a nearly straight line, to the cardinal margin; cardinal margin oblique, nearly straight; anterior end short, abruptly rounded, often a little concave below the beaks, and limited by a more or less defined sinus, which extends from the beak to the basal margin, usually at a point less than one-third the length of the shell from the anterior end. Valves moderately convex below and in the posterior portion, more convex in the middle; hinge-line oblique, about half the length of the shell; beaks subanterior, incurved and directed forward, somewhat compressed; umbo prominent, flattened anteriorly; the post-umbonal slope angular, gibbous above and gradually declining to the post-basal extremity. Test thin, marked by fine concentric striae, which are sometimes fasciculate, forming distinct elevations upon the posterior slope, and often distinct angular striae upon the antero-basal portion of

the shell, frequently becoming nearly obsolete on the umbonal region." Hall, 1885.

This species as compared with *M. concentrica* occurs in the bluer and more argillaceous Hamilton shales of Maryland. It is a well marked species and differs from the other Modiomorphas found in Maryland in the more nearly parallel cardinal and basal margins; well marked, angular umbonal ridge; subtruncate posterior end; and the obsolescence of the striae on the umbonal region. The small specimen represented by figure 5 was thought at first to show very imperfectly preserved fine striae on the posterior portion of the shell and for this reason it was referred to *Modiella pygmaea* (Conrad). Further study, however, taking more account of its form leads me to conclude that it is a young specimen of *Modiomorpha subalata* (Conrad), still younger than the one represented by fig. 1, pl. xxxix, Lamellibranchiata ii, vol. v, pt. i, Palæontology of New York. The specimen was submitted to Dr. Grabau with the above opinion who wrote me as follows: "You are right I think. I should call it young *M. subalata.* The form hardly warrants reference to *Modiella.*"

Length, 25-35 mm.; height, 15-20 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road 3½ miles southeast of Cumberland (?). HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

MODIOMORPHA MYTILOIDES (Conrad) (?)

Plate XXXIII, Fig. 7

Cypricardites mytiloides Conrad, 1841, Geol. Surv. N. Y., 5th An. Rep., p. 52.
Modiomorpha planulata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 74.
Modiomorpha mytiloides Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 277, pl. xxxvii, fig. 3; pl. xxxviii, figs. 1-16.
Modiomorpha mytiloides Clarke, 1903, N. Y. State Mus., Bull. 65, p. 450.
Modiomorpha mytiloides Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 514, fig. 691b.

Description.—Shell larger than the medium size, rhomboid-ovate, oblique; length less than twice the height; basal margin nearly straight, or very slightly concave anterior to the middle, curving to the anterior and posterior extremities; posterior margin abruptly curving below and more gently recurving toward the cardinal line; cardinal margin arcuate; anterior end narrow, extended, abruptly curved on the margin, somewhat defined by the sinus which extends from anterior to the beak to the middle of the shell. Valves moderately convex; in old shells gibbous in the umbonal region. Hinge-line oblique, extending to about the middle of the shell. Beaks appressed, situated a little more than one-fourth the length of the shell from the anterior end; umbonal region not defined; convex in young shells, becoming more gibbous in older individuals. Test of moderate thickness, concentrically striated with irregular lines of growth which are sometimes elevated into concentric ridges. The anterior muscular impression is well marked and situated just within the anterior margin below the beak. Length, from 50 to 91 mm.; height, from 29 to 50 mm.

The Maryland Collection contains a left valve, from the east bank of Evitts Creek below Wolfe Mill, from which the umbonal region is missing, that has been referred to this species. It is smaller than the normal specimens of this species and probably the shell had not reached maturity but the proportions of length and height agree with those of this species. The slope from the umbonal ridge to the cardinal line is more marked than in *M. mytiloides* and resembles more nearly that of *M. subalata* but the concentric striae and the marked contraction of the anterior end are distinctive characters of the former species. Another specimen of apparently an immature right valve of this species was found in western Maryland, the exact locality of which is unknown.

Length, 36 mm.; height, 21 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; on Hancock-Harrisonville Road about 2 miles north of Hancock.

Collection.—Maryland Geological Survey.

Genus GONIOPHORA Phillips

GONIOPHORA HAMILTONENSIS Hall

Plate XXXIII, Figs. 11-13

Sanguinolites hamiltonensis Hall, 1870, Prelim. Notice Lamellibranchiata, ii, p. 36.

Goniophora hamiltonensis S. A. Miller, 1877, Cat. Amer. Pal. Foss., p. 192.

Goniophora hamiltonensis Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 296, pl. xliii, figs. 8-15, 17-21.

Goniophora hamiltonensis Clarke, 1903, N. Y. State Mus., Bull. 65, p. 390.

Goniophora hamiltonensis Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 519, fig. 699c.

Description.—"Shell large, trapezoidal; length more than twice the height; basal margin gently curving, sometimes nearly straight and slightly affected by the sinus; posterior margin obliquely truncate; anterior margin concave below the beak and abruptly rounded below; cardinal line very slightly arcuate, extending for two-thirds the length of the shell. Valves moderately convex below the umbonal ridge, and concave above it to the cardinal line; beaks subanterior, small, closely incurved, situated from one-fourth to one-sixth the length of the shell from the anterior margin; umbonal ridge angular, strongly defined, arching over the beaks and extending in nearly a direct line to the post-basal extremity; umbonal region scarcely gibbous, separated from the anterior end by a broad undefined sinus, which becomes obsolete in some specimens. Test of moderate thickness, marked by regular, prominent, lamellose striae." Hall, 1885.

A small, exfoliated and somewhat imperfect right valve was found on the road from Hancock to Harrisonville, Penna., which is referred to this species. It has a sharp and prominent umbonal ridge, extending in a direct line from the beak to the post-basal extremity, while the posterior margin is apparently quite truncate, characters which are diagnostic of this species. It resembles quite closely fig. 12, pl. xliii, ii Lamellibranchiata, pt. i, vol. v, Pal. N. Y., and similar exfoliated specimens of this species in the New York State Museum.

Length, 20 mm.; height, 11 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. On Hancock-Harrisonville Road about 2 miles north of Hancock.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Order ANOMALODESMACEA

Superfamily ANATINACEA

Family PHOLADELLIDAE

Genus PHOLADELLA Hall

PHOLADELLA RADIATA (Conrad)

Plate XXXIII, Figs. 14-16

Nuculites radiata Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 248, pl. xii, fig. 16.
Pholadella radiata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 63.
Pholadella radiata Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 469, pl. lxxviii, figs. 15-21; pl. xcvi, fig. 1.
Pholadella radiata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 488.
Pholadella radiata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 528, fig. 716.

Description.—" Shell from small to medium size, elongate-ovate, cuneate; length about twice the height; basal margin regularly rounded, curving in a greater or less degree according to the age of the individual; posterior extremity more or less obliquely, or sometimes vertically, truncate; anterior end short, obliquely truncated by the lunule and narrowly rounded below, lunule deep, marked by an abrupt incurving of the margin; escutcheon large and well defined; cardinal line straight; sometimes a little concave. Valves, in their usual condition of preservation, moderately convex below and gibbous in the middle; beaks subanterior, prominent, strongly incurved; cincture extending from the beaks to the base of the shell as a marked depression and producing a slight sinuosity in the margin; umbonal slope prominent, often distinctly angular, extending to the post-inferior extremity; post-cardinal slope gently concave, often marked by a slight fold along the middle or by two or more radii. Surface marked by fine concentric striae and anterior to the cincture

concentric ribs; also by strong radii diverging from the beak, usually marking that portion of the shell between the cincture and the umbonal ridge, sometimes covering the entire surface." Hall, 1885.

A perfectly marked specimen of this species was found on the road from Hancock to Harrisonville, Pa., two miles north of Hancock, Washington County, on which the surface markings, so characteristic of this species, are well preserved. It was also reported by Hall from the Hamilton group near Cumberland, Md. (Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 470) one specimen of which was figured (pl. xcvi, fig. 1). This species is readily identified by its small size; cuneate outline; prominent cincture extending from the beak to the base; concentric striae and ribs anterior to the cincture; prominent radii generally from the cincture to the umbonal ridge; and obliquely to vertically truncate posterior end.

Length, about 20 mm., posterior end broken; height, 12 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. On Hancock-Harrisonville Road about 2 miles north of Hancock.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Order TELEODESMACEA

Superfamily CYPRICARDIACEA

Family PLEUROPHORIDAE

Genus CYPRICARDELLA Hall

CYPRICARDELLA BELLISTRIATA (Conrad)

Plate XXXIV, Figs. 1-4

Microdon bellastriata Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 247, pl. xiii, fig. 12.

Microdon bellastriata Hall, 1843, Geol. N. Y., pt. iv, p. 196, fig. 2.

Microdon bellastriata Rogers, 1858, Geol. Penna., vol. ii, p. 827, fig. 660.

Microdon (Cypricardella) bellistriatus Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 308, pl. xiii, figs. 17-20; pl. lxxiii, figs. 7-22; pl. lxxiv, figs. 5-10.

Cypricardella bellistriatus Grabau, 1899, Bull. Buffalo Soc. Nat. Sci., vol. vi, p. 252, fig. 169.
Microdon (Cypricardella) bellistriatus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 439.
Cypricardella bellistriata Cockerell, 1905, Am. Geol., vol. xxxvi, p. 330.
Cypricardella bellistriata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 535, figs. 727c, d.

Description.—" Shell of medium size or larger; form subrhomboidal to subelliptical; extremely variable proportions of length and height varying from a length of twice the height, to a length of less than one-third greater than the height; basal margin regularly curving anteriorly, often nearly straight in the posterior half; posterior margin almost vertically subtruncate, sometimes gently curving; anterior end narrowed, prolonged below and abruptly rounded at the extremity, constricted above by a distinct lunule; cardinal line nearly straight. Valves depressed-convex, becoming moderately convex in the umbonal region; beaks usually at about the anterior third, but often nearer the anterior extremity, small, closely appressed, scarcely rising above the hinge-line; umbonal slope continued as a low undefined ridge to the post-basal angle. Test of moderate thickness, marked by strong, even, angular striae, which continue nearly uniform in character over the entire shell." Hall, 1885.

This species is common in the thinner, somewhat arenaceous Hamilton shales of Evitts Creek below Wolfe Mill. The specimens agree closely in form and markings with those figured from New York and they present similar variations in reference to the proportions of length and height. It was identified by Hall from the Hamilton shales near Cumberland, Md. (Pal. N. Y., vol. v, pt. 1, Lamellibranchiata ii, p. 309) and the cardinal view of a specimen from this locality is figured (pl. xlii, fig. 17). The species is readily recognized by its form; nearly vertically truncate posterior end; projecting lower part of anterior end; and strong, even, angular concentric striae.

Length, 26, 30, 34 mm.; height, 21, 20, 26 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; Williams Road, ¼ mile east of Queen City Hotel, Cumberland; B. & O. R. R. cut at 21st Bridge; along Flintstone Creek in Gilpin.

Collections.—Maryland Geological Survey; American Museum of Natural History.

CYPRICARDELLA TENUISTRIATA (Hall)

Plate XXXIV, Fig. 5

Microdon tenuistriata Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 32.
Microdon (Cypricardella) tenuistriatus Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 310, pl. xlii, fig. 16; pl. lxxiii, figs. 23-30; pl. lxxiv, figs. 20, 21.
Microdon tenuistriatus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 443.
Cypricardella tenuistriata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i. p. 534, figs. 727a, b.

Description.—" Shell large, quadrangularly subovate; length one-fourth greater than the height; basal margin regularly curving; posterior margin subtruncate, from oblique to nearly vertical and gently curving; anterior end rapidly declining from the beak and abruptly rounded below; cardinal line gently arcuate. Valves depressed-convex below, rising into moderate convexity in the umbonal region; beaks at about the anterior third, small and appressed, rising a little above the hinge-line; umbonal slope scarcely defined, extending in a slightly arching direction to the post-basal extremity. Test thin, marked by fine, unequal, concentric striae, which are at intervals raised into lamelliform undulations." Hall, 1885.

A much smaller number of specimens belonging to this species was found than of *C. bellistriata.* Several characteristic specimens, however, were obtained and a figure of a cardinal view of a specimen of this species from the Hamilton group, at Cumberland, Md., was given by Hall (Pal. N. Y., vol. v, pt. 1, Lamellibranchiata ii, pl. xlii, fig. 16). This species is readily distinguished from *C. bellistriata* by its larger size; more strongly curving basal line; less prominent umbonal slope; and finer and less clearly defined striae.

Length, 42 mm.; height, 29 + mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road ¾ mile east of Queen City Hotel, Cumberland; on Hancock-Harrisonville Road about 2 miles north of Hancock.

Collections.—Maryland Geological Survey; American Museum of Natural History.

Genus CYPRICARDINIA Hall

CYPRICARDINIA INDENTA (Conrad)

Plate XXXIV, Figs. 6-10

Cypricardites indenta Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 244, pl. xii, fig. 12.
Cypricardinia indenta Hall, 1870, Prelim. Notice Lamellibranchiata 2, p. 83. (In part.)
Cypricardinia indenta Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 485, pl. lxxix, figs. 6-16, 23; pl. xcvi, fig. 2.
Cypricardinia indenta Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Cypricardinia indenta Clarke, 1903, N. Y. State Mus., Bull. 65, p. 378.
Cypricardinia indenta Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 536, fig. 729c.

Description.—" Shell of medium size, subrhomboid-ovate shape; length more than one-third greater than the height; basal margin nearly straight, slightly sinuate anterior to the middle; posterior extremity abruptly rounded below and obliquely truncate above; anterior end very short, rounded below; cardinal line straight, oblique. Right valve very convex, often extremely gibbous; left valve usually depressed convex below and posteriorly, becoming moderately gibbous in the umbonal region; beaks nearly anterior, small and appressed, rising but little above the hinge-line; cincture distinct on the right valve, less marked upon the left one; umbonal slope rounded and prominent on the right valve, subangular on the left one. Surface marked by extremely fine concentric striae and by unequally distant but somewhat regular lamellose, imbricating, concentric undulations; and in well preserved specimens the entire surface is marked by fine striae, which radiate from the apex of the shell." Hall, 1885.

Several specimens of this species were collected; most of which were obtained from the shales on Evitts Creek below Wolfe Mill. They are typical and do not differ in any noticeable respect from those figured from the Hamilton of New York. Hall reported the species from Hardy County, [W.] Virginia (Pal. N. Y., vol. v, pt. 1, Lamellibranchiata ii, p. 486). Like a number of the other Pelecypoda found in the Maryland Hamilton it is a sharply defined species so that there is no uncertainty regarding its identification. Its most striking characters are the shape; the strong, unequally distant, lamellose concentric undulations; fine

radiating striae; convex valves; slightly sinuate basal margin; and distinct cincture on right, which is not marked on the left valve.

Length, 11 mm.; height, 6 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; B. & O. R. R. cut at 21st Bridge.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Superfamily LUCINACEA

Family LUCINIDAE

Genus PARACYCLAS Hall

PARACYCLAS LIRATA Conrad

Plate XXXIV, Figs. 11-14

Posidonia lirata Conrad, 1838, Geol. Surv. N. Y., An. Rep., p. 16, pl. [unnumbered], fig. 12.

Lucina (Paracyclas) lirata Hall and Whitfield, 1872, Twenty-fourth An. Rep. N. Y. State Mus. Nat. Hist., p. 200.

Paracyclas lirata Hall, 1885, Pal. N. Y., vol. v, pt. 1, Lamellibranchiata ii, p. 441, pl. lxxii, figs. 2-19; pl. xcv, fig. 19.

Paracyclas lirata Clarke, 1903, N. Y. State Mus., Bull. 65, p. 483.

Paracyclas lirata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. 1, p. 555, fig. 760b.

Description.—"Shell of medium size, subcircular or broadly elliptical; length a little greater than the height; margins regularly rounded; cardinal line short, less than half the length of the shell. Valves moderately convex below, becoming gibbous on the middle and above; beaks anterior to the center, small, appressed, rising but little above the hinge-line; post-cardinal slope not defined. Surface marked by fine concentric striae, and by strong subangular concentric ridges, which are more or less sharply defined, depending upon the condition of the specimen and the nature of the matrix in which the fossil is imbedded." Hall, 1885.

Several specimens of medium size of this species were collected and one of the large forms. These do not show any particular variation from the forms figured from New York and are clearly that species. Their most

prominent characters are their medium size; nearly circular outline; and strong, irregular concentric ridges.

Length, medium size, 12, 13 mm.; height, 12 mm.

There is a large specimen from McCoys Ferry which is somewhat elongated by pressure and measures 29 mm. in length by 27 in height (plate xxxiv, fig. 15). This has very strong concentric ridges which usually divide at a distance from the margins. It has not been separated from *P. lirata,* because but a single specimen is known although it may prove to be distinct enough to form a new variety. The specimen was submitted to Dr. Grabau who wrote "I think perhaps the stronger compound wrinkles would make this a distinct variety of *P. lirata.*"

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill (?); McCoys Ferry; southwest of McCoys Ferry; on Oldtown Road east of Maryland Ave., Cumberland; on Hancock-Harrisonville Road about 2 miles north of Hancock; on National Road in Gilpin; west of Lock No. 56 at Great Cacapon; W. Va. side Potomac River about 3 miles south of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

PARACYCLAS TENUIS Hall

Plate XXXIV, Figs. 16, 17

Paracyclas tenuis **Hall, 1883, Pal. N. Y., vol. v, pt. i, plates and explanations, pl. lxxii, figs. 20-22.**
Paracyclas tenuis **Hall, 1885, Pal. N. Y., vol. v, pt. i, Lamellibranchiata ii, p. 443, pl. lxxii, figs. 20-22; pl. xcv, fig. 25.**
Paracyclas tenuis **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 485.**

Description.—"Shell small, subcircular; length and height about equal; margins regularly curving; cardinal line short. Valves moderately convex; beaks a little anterior to the middle, small, closely appressed, scarcely rising above the hinge-line; post-cardinal slope curved and rapidly declining backward, limited by the ligamental groove, which is very distinctly marked. Test extremely thin; surface marked by very fine concentric striae, which are sometimes aggregated into fascicles toward the pallial margin." Hall, 1885.

The external impressions of two left valves apparently of this species were found in the thin shales of Evitts Creek. The shells are small, apparently thin, with length and height about equal, surface marked by very fine concentric striae and one specimen in addition shows rather indistinct concentric ridges. The valve with simply the fine striae is quite near specimens of this species which the writer has collected in the Hamilton beds of New York.

Length, 8½ mm.; height, 9 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; New York State Museum.

Superfamily SOLENACEA

Family SOLENIDAE

Genus PALAEOSOLEN Hall

PALAEOSOLEN MINUTUS n. sp.

Plate XXXIV, Fig. 18

Description.—Shell solenoid and rather small; length three times the height; basal and cardinal margins nearly parallel, the cardinal straight and the basal slightly rounded toward the extremities; anterior end apparently rounded; posterior extremity truncate and probably gaping. Valves somewhat convex their entire length; beaks subanterior and not clearly defined; umbonal slope marked by a very indistinct diagonal groove. Surface anterior to the umbonal groove marked by fine concentric striae while posterior to it the impression apparently shows indistinct undulations.

This species is apparently closely related to *P. siliquoideus* Hall but differs from it in its much smaller size and greater proportionate height. This specimen has only one-fifth the length and nearly one-half the height of *P. siliquoideus.*

Length, 13 mm.; height, 4½ mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road ¼ mile east of Queen City Hotel, Cumberland.

Collection.—Maryland Geological Survey.

CLASS GASTROPODA

Subclass STREPTONEURA

Order ASPIDOBRANCHIA

Suborder RHIPIDOGLOSSA

Family PLEUROTOMARIIDAE

Genus PLEUROTOMARIA Defrance

Subgenus BEMBEXIA Oehlert

PLEUROTOMARIA (BEMBEXIA) SULCOMARGINATA Conrad

Plate XXXV, Figs. 1-5

Pleurotomaria sulcomarginata Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 272, pl. xvi, fig. 13.

Pleurotomaria sulcomarginata Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 46, pl. v, figs. 9, 10.

Pleurotomaria sulcomarginata Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 69, pl. xix, figs. 8-17.

Bembexia sulcomarginata Ulrich and Scofield, 1897, Geol. Minn., vol. iii, pt. ii, p. 955.

Bembexia sulcomarginata Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 647, fig. 883.

Description.—" Shell depressed trochiform; spine moderately elevated; apex minute; volutions four or five, very depressed convex on the upper side, gradually enlarging to the last one which becomes somewhat ventricose; aperture subquadrate, somewhat wider than high, the columella much extended below. Surface marked by two distinct, narrow, revolving carinae on each volution, one just below the suture, and the other near the periphery, with finer intermediate striae which are rarely visible; the entire surface marked by strong, regular and even concentric striae which crenulate the revolving carinae, and, passing over the lower one, bend backward to the concave peripheral band; suture sometimes sharply canaliculate." Hall, 1879.

A considerable number of fairly large and smooth, with the exception of a convex band about the periphery of the last whorl, internal impressions occur in the Hamilton beds of Maryland and the adjacent part of

West Virginia. In addition, however, there are in some of the finer and more argillaceous shales rather badly crushed specimens of the shell which show distinctly the characteristic surface markings. Furthermore, Hall stated that "this species extends in a southwesterly direction to Maryland and Virginia" and that casts of the species from Maryland rounded or subangular on the periphery "measure one inch and a half in diameter, and one inch and three-eighths in height, and consist of about five distinct volutions" (Pal. N. Y., vol. v, pt. ii, p. 70); while a large internal cast from the Hamilton group at Cumberland is figured (see pl. xix, fig. 15). Large internal impressions agreeing in size, number of whorls and apparently all characters, except that perhaps the revolving band on the body-whorl is not so strong, with the figure just mentioned were collected on the West Virginia bank of the Potomac River, opposite Madder's Island, four miles south of Cumberland; while specimens from the same side of the river about three miles south of Cumberland agree closely in form, strength of striae and other characters with figure 9 of the same plate which represents a specimen from the Hamilton of New York. Internal impressions and the outside of specimens from West Virginia and Maryland were compared with corresponding ones, labeled as belonging to this species, in the office of the New York State Paleontologist and found to agree satisfactorily. The most distinctive characters of the species are the shape, size, carinae and strong concentric striae.

Length, 35, 32, 18 mm.; width, 40, 37, 22 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East side Warrior Mt. east of Rush; Town Creek Road at Geo. Diefenbaugh's; on National Road ½ mile west of Tonoloway Ridge (?); west of iron bridge over Town Creek northeast of Oldtown; on Oldtown Road east of Maryland Ave., Cumberland; on Hancock-Harrisonville Road about 2 miles north of Hancock; Ernstville; along Flintstone Creek in Gilpin; W. Va. side Potomac River 3 and 4 miles south of Cumberland; on road about half way between Romney and Hanging Rock, W. Va.; on Romney-Hanging Rock Road about ½ mile north of Romney, W. Va.

Collections.—Maryland Geological Survey; American Museum of Natural History.

Subgenus GYROMA Oehlert

PLEUROTOMARIA (GYROMA) CAPILLARIA Conrad

Plate XXXV, Figs. 6-8

Pleurotomaria capillaria Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 271, pl. xvi, fig. 11.

Pleurotomaria capillaria Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 45, pl. v, fig. 2.

Pleurotomaria capillaria Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 77, pl. xx, figs. 18-21.

Pleurotomaria capillaria Clarke, 1903, N. Y. State Mus., Bull. 65, p. 555.

Gyroma capillaria Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 647, fig. 882.

Description.—" Shell turreted, one-fourth to one-third higher than wide; volutions four or more, somewhat rapidly increasing in size, the last one ventricose, subangulated above by two or three prominent revolving carinae, and rounded on the lower side; aperture subrhomboidal. Surface on the upper side of the volutions marked by two or three revolving carinae, with finer intermediate ones or strong striae, and all are crenulated by finer distant transverse striae; lower side of volutions marked by regular, strong, revolving cariniform striae, which are more approximate as they approach the umbilical depression, and all crenulated by concentric striae; peripheral band narrow and prominent, margins carinate, and the intermediate space marked only by curving striae; above and below the band, there is usually a broader smooth space than between the cariniform striae." Hall, 1879.

A few specimens were obtained, mostly from Evitts Creek below Wolfe Mill, which possess the typical surface markings of this species. The proportions of height and width are nearly equal on one specimen and therefore do not agree with the above description, but the specimen is somewhat shortened by pressure; while in a smaller one that is not crushed the proportions are about normal. This species is recognized most readily from its size, shape, and revolving striae which are never equal, and are crenulated by the finer transverse striae.

Length, shortened by crushing, 17, 14 mm.; width, 17, 10½ mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; on Hancock-Harrisonville Road about 2 miles north of Hancock; B. & O. R. R. cut at Hancock Station, W. Va. (?).

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Subgenus TREPOSPIRA Ulrich and Scofield

PLEUROTOMARIA (TREPOSPIRA) ROTALIA Hall (?)

Plate XXXV, Figs, 9, 10

Pleurotomaria rotalia **Hall, 1861, Descriptions of New Species of Fossils, p. 18.**

Pleurotomaria rotalia **Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 46, pl. v, fig. 11.**

Pleurotomaria rotalia **Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 71, pl. xix, figs. 20-25.**

Trepospira rotalia **Ulrich and Scofield, 1897, Geol. Minn., vol. iii, pt. ii, p. 957.**

Trepospira rotalia **Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 648.**

Description.—" Shell small, depressed-trochiform; apex minute; spire consisting of about four volutions, which gradually expand to the aperture; slope of the spire from the apex to the periphery nearly in the same plane, being very slightly convex; aperture subquadrate; lower side concave, with a comparatively large umbilical depression, which is surrounded by a distinct areola. Surface very finely and closely striate parallel to lines of growth; striae not prominent, sometimes obscurely fasciculate, and always bending abruptly backward as they approach the narrow peripheral band; suture line depressed and narrowly canaliculate, with sometimes a subdued or obsolescent revolving carina just below, near the upper margin of the volution." Hall 1879.

The specimens are mainly broken, smooth, internal impressions not showing much more than the body-whorl and a part of the first volution of the spire, however, so far as preserved they apparently agree with figure 25 of the Palæontology of New York which represents an enlarged

smooth internal impression[1] of this species and further agree in having a less elevated spire than *P. sulcomarginata.* On a portion of the body-whorl one specimen has preserved the surface markings, fine and close striae parallel to lines of growth like those of *P. rotalia;* while there are no indications of revolving striae. It is thought that the low spire and fine concentric striae, which are the two most distinguishing characters of *P. rotalia,* are sufficient evidence for referring these specimens with a question to this species.

Length, not shown; width, 12-19 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry; southwest of McCoys Ferry; National Road ½ mile west of Tonoloway Ridge; in Jennings Run ½ mile west of Corriganville; Ernstville.

Collection.—Maryland Geological Survey.

Subgenus EURYZONE Koken

PLEUROTOMARIA (EURYZONE) ITYS Hall (?)

Plate XXXV, Figs. 11-12

Turbo lineatus Hall, 1843, Geol. N. Y., pt. iv, p. 198, fig. 1.
Pleurotomaria lineata Hall, 1861, Descriptions of New Species of Fossils, p. 16.
Pleurotomaria lineata Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 44, pl. v, fig. 3.
Pleurotomaria itys Hall, 1876, Illustrations of Devonian fossils: Gasteropoda, pl. 20.
Pleurotomaria itys Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 76, pl. xx, figs. 8-17.
Pleurotomaria itys Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Pleurotomaria itys Clarke, 1903, N. Y. State Mus., Bull. 65, p. 556.
Euryzone itys Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 645, fig. 879e.

Description.—"Shell turbinate; spire ascending, higher than wide; volutions four or five, regularly and evenly convex, gradually expanding to the body-whorl, which is ventricose, rounded below and concave in the middle; umbilicus small or none; aperture broadly oval, somewhat higher than wide. Surface marked by strong, regular, revolving striae on the upper and lower sides of the volutions, crossed and cancellated by fine,

[1] *Loc. cit.*, vol. v, pt. ii, pl. xix.

concentric striae, which are directed gently backward from the suture, and scarcely showing any greater curve as they approach the peripheral band; the band is of moderate width, simple, and limited on the two sides by a linear carina, within which the simple concentric striae make an abrupt retral curve; the concentric striae above and below the band are of similar character, while the revolving striae are finer on the lower side." Hall, 1879.

The Maryland specimens are in the form of smooth internal impressions which show scarcely any structural markings. In size they agree very well with the specimen represented by figs. 11 and 12, pl. XX, pt. ii, vol. v, Pal. N. Y., but there is no indication of the sutural band, and apparently the body-whorl is not so closely attached to the base of the spire. Hall reported casts of this species in Maryland and [W.] Virginia (*loc. cit.* p. 77) and gave two views of an internal cast (pl. xx, figs. 9 and 10) from Cumberland which show, however, somewhat faintly a spiral band on the last volution. Some of the specimens were submitted to Dr. Grabau who wrote as follows: "I should incline to *P. itys*, but these casts are so unreliable that I would not do more than refer it with a question mark."

Length, about 20, 28 mm.; width, about 18, 22 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Western Maryland; Williams Road, ¼ mile east of Queen City Hotel, Cumberland; on National Road northeast of Cumberland; Robinson farm 2 miles south of Patterson Depot, W. Va.

Collection.—Maryland Geological Survey.

Genus BELLEROPHON Montf

Subgenus BUCANOPSIS Ulrich

BELLEROPHON (BUCANOPSIS) LEDA Hall

Plate XXXVI, Figs. 1-3

Bellerophon leda **Hall, 1861, Descriptions of New Species of Fossils, p. 30.**
Bellerophon leda **Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 58.**
Bellerophon leda **Hall, 1875, Twenty-seventh Rep. N. Y. State Mus. Nat. Hist., pl. xiii, fig. 1.**

Bellerophon leda Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 110, pl. xxiii, figs. 2-16.
Bucanopsis leda Ulrich and Scofield, 1897, Geol. Minn., vol. iii, pt. ii, p. 854.
Bellerophon leda Clarke, 1903, N. Y. State Mus., Bull. 65, p. 524.
Bellerophon (*Bucanopsis*) *leda* Clark and Mathews, 1906, Md. Geol. Surv., vol. vi, pl. xvii, fig. 12.
Bucanopsis leda Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 623, fig. 837.

Description.—" Shell subglobose, often a little flattened upon the dorsum; body-whorl ventricose, very rapidly expanding; aperture very wide; peristome abruptly spreading, broadly sinuate in front and sometimes with a deeper notch in the middle, the margin joining the volution a little on the ventral side, where it is thickened, somewhat abruptly curving over and partially enclosing the small umbilicus. Surface marked by strong longitudinal or revolving striae, which alternate in size, are sometimes fasciculate, and often finer and more numerous on each side of the dorsal band than on the lateral portions of the shell; the revolving striae are cancellated by finer, subequal, thread-like transverse striae; the dorsal band is narrow, rarely elevated or sometimes scarcely raised above the surface, and usually flat or slightly concave, the concentric striae making an abrupt retral curve upon it in crossing." Hall, 1879.

A broken specimen of this species was found in the thin argillaceous shales of Evitts Creek below Wolfe Mill. Although it is a very imperfect specimen, still on account of the well preserved highly characteristic surface markings it is thought that there is no doubt regarding its identification. The ventricose and expanded body-whorl; alternating revolving striae, cancellated by transverse ones; and flat dorsal band upon which the transverse striae make an abrupt retral curve are clearly shown and very distinctive characters.

Length of imperfect specimen, 20 mm.; width, near front margin, 26 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Subgenus PATELLOSTIUM Waagen

BELLEROPHON (PATELLOSTIUM) PATULUS Hall (?)

Plate XXXV, Fig. 14

Bellerophon patulus Hall, 1843, Geol. N. Y., pt. iv, p. 196, fig. 1.
Bellerophon patulus Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 57.
Bellerophon patulus, 1879, Pal. N. Y., vol. v, pt. ii, p. 100, pl. xxii, figs. 17-30; pl. xxiv, figs. 3-10; pl. xxvi, figs. 10-12.
Bellerophon patulus Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Patellostium patulus Ulrich and Scofield, 1897, Geol. Minn., vol. iii, pt. ii, p. 854.
Bellerophon patulus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 526.
Ptomatis patulus Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 624, fig. 841.

Description.—" Shell subglobose, ventricose; umbilicus small, closed before reaching the center; volutions rounded, the last one abruptly and widely dilated, giving a broad subcircular aperture, the width greater than the dorso-ventral diameter; the lip somewhat flattened and repand towards the exterior margin and broadly sinuate in front, contracted and more or less thickened at the postero-lateral margins, nearly inclosing and partially overlapping the volution on the posterior side, and extending more or less entirely over the columellar lip in a thickened callus, the exterior portion of which is pustulose. Surface, on the expanded part of the outer volution, marked by fine, close, concentric striae, which are sometimes crowded in fascicles, giving an undulating surface; the posterior prominent part of the volution is marked on the back, and partially on the sides, by strong, even, arching costae, which are more abruptly and sometimes subangularly curved on the dorsal line. These costae sometimes continue for half the length of the volution anteriorly, gradually becoming obsolete on the middle and sides, and are never seen upon the broad expansion of the shell; the spaces between the costae marked by fine, close, concentric striae, and in well-preserved specimens, extremely fine revolving striae are sometimes visible. The interior cast, is smooth. This shell can usually be readily distinguished by its widely expanded outer volution, the broad, shallow, sinuosity in the anterior

margin of the lip, and the absence of all markings on this part of the shell except striae of growth." Hall, 1879.

In the Maryland Collection is a single smooth, broken and poorly preserved internal impression which is doubtfully referred to this species. Hall states that "It is not rare in the form of casts near Cumberland, Md." (Pal. N. Y., vol. v, pt. ii, p. 103) and on comparison the specimen was found to agree as nearly with the interior views of some of the type specimens of this species in the office of the New York State Paleontologist as with those of any other species.

Length, about 32 mm.; width of expanded part of lip more than 35 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Western Md.; on road 1 mile north of Romney, W. Va. (?).

Collection.—Maryland Geological Survey.

Genus CYRTOLITES Conrad

Subgenus CYRTONELLA Hall

CYRTOLITES (CYRTONELLA) MITELLA Hall

Plate XXXVI, Figs. 4-7

Cyrtolites (?) *mitella* Hall, 1861, Descriptions of New Species of Fossils, p. 33.

Cyrtolites mitella Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 61.

Cyrtolites mitella Hall, 1876, Illustrations of Devonian Fossils: Gasteropoda, pl. xxv, figs. 16-18.

Cyrtolites mitella Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 123, pl. xxv, figs. 23-28.

Description.—"Shell arcuate, subovoid, making altogether less than two volutions in the same plane; the first volution very minute; the body-whorl rapidly expanding to the aperture, which is nearly circular; the peristome scarcely spreading; the shell carinate, and the casts obtusely but distinctly angular on the dorsum; apparently not sinuate or but slightly undulated on the anterior margin. Surface marked by regular, sharply elevated, subparallel, transverse striae, which are comparatively distant (at least twice or thrice their width) near the apex and on the upper part of the outer volution, but become more crowded towards the front of the shell; on the upper part and sides of the shell the inter-

mediate spaces are regularly cancellated by short revolving striae which hardly rise so high as the transverse ones, giving the entire surface a pitted or finely reticulate character; approaching the margin, the spaces between these striae diminish, as the result of the rate of growth in the shell, and they often become so crowded as to present the character of simple undulating granulose lines of growth; the striae are not curved in passing over the rounded carina; when the shell is partially exfoliated they give a lamellose-striate character to the surface. The fossil is usually found in the condition of casts of the interior, which preserve some marks of the transverse striae, but the exterior shell is rarely seen." Hall, 1879.

There are internal impressions in the Maryland Collection which are referred to this species. The dorsum is conspicuously subcarinate, the transverse striae are clearly shown and are crowded toward the front of the shell, while the revolving striae are rather faintly shown on the upper part of one specimen.

Length of largest specimen, about 22 mm.; width, about the same.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. About 4 miles north of Oldtown on road east of Pine Hill; B. & O. R. R. cut at 21st Bridge; on National Road in Gilpin.

Collections.—Maryland Geological Survey; American Museum of Natural History.

Family TURBINIDAE

Genus CYCLONEMA Hall

CYCLONEMA HAMILTONIAE Hall (?)

Cyclonema hamiltoniae Hall, 1861, Descriptions of New Species of Fossils, etc., p. 19.

Cyclonema hamiltoniae Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 47, pl. v, fig. 16 (not 15).

Cyclonema hamiltoniae Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 37, pl. xii, figs. 34-36.

Sphaerodoma hamiltoniae Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 701.

Description.—"Shell subglobose-conical; height a little more than the width across the last volution; volutions four or five; apex minute and

gradually expanding to the body-whorl which is somewhat abruptly ventricose, flattened or a little concave for a short distance below the suture, and the space limited on the exterior side by a carina, which is the first of a series, marking the periphery of the volution. Surface marked by extremely fine lamellose lines of growth, which are directed backwards from the suture without bending or curvature in passing the carinations; the volutions, except the narrow concave space above, are marked by strong revolving elevated carinate lines, of which there are from fourteen to eighteen on the body-whorl; these carinae are usually simple and subequal, more or less distinctly defined, and sometimes alternately stronger and more subdued, or with two finer ones between the stronger; on each of the upper volutions there are three, four or five of these carinae preserved, and they are distinctly crenulated by the passage of the concentric striae, which are sometimes also bent forward on approaching the first carination." Hall, 1879.

One specimen from the West Virginia side of the Potomac River four miles below Cumberland shows very distinctly four whorls which are similar in form to those of this species. The surface markings, however, are imperfectly preserved; but on the upper half of the body-whorl are more or less clearly shown portions of seven revolving carinate lines. Similar carinate lines are very poorly shown on the lower half of this whorl, while the fine lines of growth are scarcely shown at all.

Length, 26 mm.; width, 22 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East side Warrior Mt. east of Rush; on Hancock-Harrisonville Road about 2 miles north of Hancock; W. Va. side Potomac River 4 miles south of Cumberland.

Collection.—Maryland Geological Survey.

CYCLONEMA LIRATUM VAR. GRABAUI n. var.

Plate XXXVI, Figs. 8, 9

Description.—Volutions four, subangular, sloping gradually from the suture to the first carinate ridge, of which two are visible on the upper

volutions and four on the upper half of the external impression of the body volution. The internal impression or mold of the body-whorl of this same specimen shows at least six carinate ridges or spirals. Surface marked by rather fine, closely arranged striae of growth.

This description is based on the external and internal impressions of a specimen which is intermediate between *C. liratum* Hall and *C. multiliratum* Hall. It is probably nearer the former species and its most marked difference is in the greater number of carinate ridges on the body-whorl, since it probably has about eight while *C. liratum* is given as having about five, *C. multiliratum* from ten to twelve, and *C. hamiltoniae* from fourteen to eighteen. There are some other rather slight differences in these species; but the variation in the number of carinate lines is the most conspicuous one. Dr. Grabau has clearly shown how these elevated lines or "spirals" increase in number in the development of this general type of Gastropoda. He says: "The primary ones are the first to appear, and they increase in number by the exogenous appearance of new ones on the upper and lower portions of the whorl, outside of those which appeared first. Secondary spirals appear *between* the primary ones as these diverge, owing to the uniform increase in size of the whorls. . . . . This teaches us that in the primitive type of a series we may expect to find primary spirals only, even in the adult, and experience shows that these are characteristic of the earlier members of any series."[1] These specimens were examined by Dr. Grabau who wrote as follows concerning the external impression: "This is most interesting. It is a form between *C. liratum* and *C. hamiltoniae.* It is nearer to *C. liratum;* but has a secondary spiral between the primary ones on the last volution. This indicates clearly a more accelerated condition than *liratum;* but these have not yet become so numerous as in *hamiltoniae.*" Later he examined the internal mold and stated that it "gives evidence of additional spirals. While this is probably a descendant of the Ordovicic Cyclonemas it might be questioned whether it had not better be placed in a distinct genus." The name of this variety is given in honor of Dr. Grabau who first called my attention to

[1] Amer. Nat., vol. xxxvi, Dec. 1902, p. 927.

the importance of these carinate ridges in tracing the development of these species.

Length, greater than 15 mm.; width, probably more than 16 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Williams Road about 3½ miles southeast of Cumberland and near the top of the Hamilton.

Collection.—Maryland Geological Survey.

CYCLONEMA (?) MARYLANDENSE n. sp.

Plate XXXVI, Fig. 10

Description.—Shell subconical; width across the last volution a little less than the height (in this specimen about ⅞ths); volutions four. Body-whorl rather ventricose, upper portion sloping gradually from the suture to its conspicuous ventricose part; the entire surface marked by revolving elevated lines of similar and medium strength of which there are about eighteen on the body-whorl, and eight or nine on the second whorl.

In the number of revolving lines this specimen agrees quite closely with *Cyclonema hamiltoniae* Hall; but differs markedly from it in the gradually sloping upper part of the body-whorl marked by revolving lines while in the species just cited that part of the body-whorl is more or less flattened and smooth.

The collection contains but a single specimen of this species from western Maryland, the exact locality of which is unknown, which was submitted to Dr. Grabau who wrote as follows: "I suppose the best thing to do would be to refer this to *Cyclonema*. I am, however, inclined with Ulrich to hold that there are no true Cyclonemas in the Devonic. The present specimen appears to be a more primitive type than the Ordovicic Cyclonemas, since the spiral lines are simple, *i. e.*, only primary ones—as near as can be determined from this specimen—while typical *Cyclonema* eg. *bilix* Conrad has intercalated spirals. Hall's *C. doris* from the Schoharie is not unlike this, though I suspect his specimen was broken at the base. I should advise describing this specimen as *Cyclonema* (?) n. sp." Ulrich has expressed the following opinion regarding the Devonian Cy-

clonemas: "We have not had an opportunity to examine any of the Devonian species that are referred to *Cyclonema* by various authors, but judging from the literature alone we feel satisfied that not one has a sufficient right to maintain its position in the genus." [1]

Length, 26 mm.; width, 22 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. W. Va. bank of Potomac River 4 miles below Cumberland.

Collection.—Maryland Geological Survey.

NATICOPSIS sp.

Plate XXXVI, Fig. 11

Naticopsis sp. undet. Kindle, 1912, Bull. U. S. Geol. Survey, No. 508, p. 98, pl. viii, fig. 11.

Description.—"Casts of a small species of Naticopsis of undetermined identity occur in the dark shale at some localities." Kindle, 1912.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road $3\frac{1}{2}$ miles east of Cumberland.

Collection.—U. S. National Museum.

Order CTENOBRANCHIATA

Suborder PLATYOPODA

Superfamily GYMNOGLOSSA

Family PYRAMIDELLIDAE

Genus MACROCHILUS Phillips

MACROCHILUS HAMILTONIAE Hall

Plate XXXVI, Figs. 12-15

Macrochilus hamiltoniae Hall, 1861, Descriptions of New Species of Fossils, etc., p. 21.

Macrochilus hamiltoniae Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 49, pl. iv, fig. 2.

Macrochilus hamiltoniae Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 33, pl. xii, figs. 8-14.

[1] Geol. of Minn., vol. iii, pt. ii, 1897, p. 1058.

Description.—"Shell very ventricose; spire short, consisting of four or five volutions, the last one extremely ventricose, making nearly two-thirds the entire height of the shell; aperture longitudinally oval, obtuse below. Surface distinctly striated by fine lines of growth; suture-line deeply impressed." Hall, 1879.

The Maryland specimens are all internal impressions which are almost if not quite smooth. The size and form of the shell, number of volutions, the ventricose body-whorl which is about two-thirds the entire length of the shell (in one specimen the shell is 21 mm. in length and the body-whorl 14 mm.), and the deep suture-lines noted on the Maryland specimens are, however, quite distinctive characters of this species. Toward the aperture of several specimens are indications of somewhat strong folds, probably of growth and perhaps striae are faintly shown crossing the body-whorl in the same direction as the folds.

Hall figured the opposite sides of an internal impression from the Hamilton at Cumberland, Md., which he called this species (Pal. N. Y., vol. v, pt. ii, pl. xii, figs. 10, 11) and many of these specimens agree almost exactly with these two figures. The internal impressions are somewhat similar to those of *Pleurotomaria itys* Hall but do not show any indication of the spiral band which characterizes the internal impressions of that species.

Length, 21-23 mm.; width, 18-19 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Western Maryland.

Collections.—Maryland Geological Survey; American Museum of Natural History.

Genus LOXONEMA Phillips

LOXONEMA HAMILTONIAE Hall

Plate XXXVI, Figs. 16-19

Loxonema nexilis Hall, 1843, Geol. N. Y., pt. iv, p. 201 (not Phillips).
Loxonema hamiltoniae Hall, 1861, Descriptions of New Species of Fossils, etc., p. 25.

Loxonema hamiltoniae Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 53, pl. iv, fig. 8.
Loxonema hamiltoniae Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 46, pl. xiii, figs. 15, 17.
Loxonema hamiltoniae Clarke, 1903, N. Y. State Mus., Bull. 65, p. 539.
Loxonema hamiltoniae Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 693, fig. 989.

Description.—" Shell elongate; volutions moderately convex, about thirteen in the largest specimens, very gradually increasing in size from the minute apex, the last one ventricose; aperture ovate, narrowing below; columella extended. Surface marked by longitudinal sharp, curving striae, which bend gently backward from the suture, and forward towards the base of the volution, having the greatest curve near the middle, those of the last volution curving abruptly backward to the columellar lip; striae separated by distinctly defined grooves which are a little wider than the ridges; the striae increasing in distance as the shell grows older." Hall, 1879.

A specimen in the Maryland Collection shows clearly five whorls and the impression of two additional ones. The volutions are fairly convex, crossed by rather coarse, sharp curving longitudinal striae, which are separated by grooves somewhat wider than the ridges. At the sutures there is no banding of the upper edge of the volution as in the closely related species of *L. delphicola* Hall, the absence of which together with the agreement of the other characters with those of *L. hamiltoniae* is regarded as proving the correctness of the identification of this specimen as *L. hamiltoniae.* All the type specimens of *L. delphicola* Hall in the office of the New York State Paleontologist show a prominent sutural band.

Length of the last five volutions, 17 mm.; width of last volution, about 8 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland. HAMILTON MEMBER. 4½ miles northeast of Oldtown; east bank Evitts Creek below Wolfe Mill; on road about half way between Romney and Hanging Rock, W. Va.; on road 1 mile north of Romney, W. Va. (?).

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Superfamily TAENIOGLOSSA

Family CAPULIDAE

Genus PLATYCERAS Conrad

PLATYCERAS ERECTUM Hall (?)

Plate XXXVII, Figs. 1-3

Acroculia erecta **Hall, 1843, Geol. N. Y., pt. iv, p. 174, fig. 6 on p. 172.**
Platyceras erectum **Hall, 1861, Descriptions of New Species of Fossils, p. 4.**
Platyceras erectum **Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 32.**
Platyceras erectum **Hall, 1876, Illustrations of Devonian Fossils: Gasteropoda, pl. ii.**
Platyceras erectum **Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 5, pl. ii, figs. 4-11.**
Platyceras erectum **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 549.**
Platyceras erectum **Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 683, fig. 963a.**

Description.—Shell regularly arcuate to the inrolled spire; nearly two volutions; the spire at the apex closely inrolled for about one and one-half volutions beyond which the body volution expands somewhat rapidly; the aperture often spreading, not infrequently oblique with a sinuate peristome. Surface marked by closely arranged, revolving, lamellose striae, which, upon the lower half of the body volution, are abruptly arched along narrow bands, corresponding with former sinuosities of the aperture.

The collection contains several exfoliated and essentially smooth specimens which agree more nearly with this species than any other. The margins are very imperfectly shown but there are radiating bands or ridges shown on the lower part of the body volution of two specimens. The specimens were sent to Dr. Grabau with the question whether he would agree in referring them to *P. erectum* and he answered as follows: "That is as close as you can get I think. Each individual of Platyceras represents a distinct mutation, no two being exactly alike." Dr. Grabau has called attention to the difficulties attending the systematic study of

the Devonian Platycera in the following language: "In the Devonian the phylogerontic [old aged] noncoiling Platycera abound. We find all degrees of coiling, from the close-coiled nonumbilicate Diaphorostoma, which appears with slight modifications throughout most of the series, to the straight 'Orthonychia,' which appears as a terminal member in most groups. Very often a number of species of 'Platyceras' can be traced to a species of Diaphorostoma or Strophostylus occurring with them, the gradations being perfect. From such evidence it appears that the numerous species classed together as Platyceras must be split up into groups, each of which has been derived from a close-coiled ancestral species, probably within the same geological horizon. If so, the name Platyceras becomes meaningless for generic purposes. The great difficulty which besets the proper breaking up of what appears most certainly to be a group of polyphyletic origin lies in the small number of ornamental characters which can be made use of in tracing out relationships."[1]

Length of largest specimen, more than 23 mm.; diameter from posterior to anterior side of aperture, 11 mm. or more.

Occurrence.—Romney Formation, Hamilton Member. On Hancock-Harrisonville Road about 2 miles north of Hancock.

Collection.—Maryland Geological Survey.

Platyceras cf. symmetricum Hall

Plate XXXVII, Fig. 6

Description.—A single poorly preserved, exfoliated specimen which is incurved nearly in the same plane, the body-whorl expanded rapidly toward the front and about equally on each side of the dorsum while the surface shows obscure longitudinal ridges. The specimen was sent to Dr. Grabau who reported as follows: "I think no two Platycera ever agree. This comes nearest to *P. symmetricum* it seems to me."

Length, about 27 mm.; transverse diameter of aperture, about 25 mm.

[1] Am. Nat., vol. xxxvi, Dec. 1902, p. 939.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collection.—Maryland Geological Survey.

Genus DIAPHOROSTOMA Fischer

DIAPHOROSTOMA LINEATUM (Conrad)

Plate XXXVII, Figs. 7-12

Platyostoma lineata **Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 276, pl. xvii, fig. 7.**

Platyostoma lineata **Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 21, pl. x, figs. 1-21.**

Diaphorostoma lineatum **Clarke, 1901, N. Y. State Mus., Bull. 49, p. 131.**

Diaphorostoma lineatum **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 533.**

Diaphorostoma lineatum **Grabau and Shimer, 1909, N. Am. Index Fossils, vol. i, p. 680, fig. 953.**

Description.—"Shell subovate, approaching to subglobose; spire elevated above the body-whorl, though varying in degree; when entire, four or five volutions, but seldom preserving more than three, the apex being usually imperfect; the body-whorl usually very ventricose, regularly convex and a little depressed below the suture line; aperture suborbicular in perfect specimens, sometimes subrhomboidal; outer lip thin, with a sharp entire margin, columellar lip thickened. Surface marked by fine, nearly equidistant, thread-like revolving striae, which are cancellated by fine concentric striae of about the same strength, but unequally distant. In well-preserved specimens, the surface is beautifully cancellated and in worn and partially exfoliated specimens, some remains of these surface markings are usually visible." Hall, 1879.

This species is not common in Maryland but one specimen was obtained which apparently clearly belongs to this species. It shows three volutions of similar size, shape and appearance to the figures of this species from the Hamilton of New York, with the exception that the median part of the body-whorl is somewhat broadly ridged and not so regularly convex from the upper to the lower edge as represented in the figures. The surface markings are well preserved on portions of the last two volutions and show that it is beautifully cancellated, the revolving striae a little

wavy and crossed by slightly finer concentric striae. The number of volutions, large ventricose body-whorl and cancellated surface are distinctive characters of this species. Small, compressed specimens from Evitts Creek below Wolfe Mill and road east of Pine Hill about four miles north of Oldtown are identified by Dr. J. M. Clarke as "not very far from *Platyostoma lineatum*."

Length, 23 mm.; width, 27 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Ernstville; Evitts Creek below Wolfe Mill (?); east of Pine Hill 4 miles north of Oldtown (?); National Road ½ mile west of Tonoloway Ridge; southwest of McCoys Ferry; west of Lock No. 56 at Great Cacapon.

Collections.—Maryland Geological Survey; American Museum of Natural History.

Genus PLATYOSTOMA Conrad

PLATYOSTOMA cf. EUOMPHALOIDES Conrad

Plate XXXVII, Figs. 13-15

Platyostoma euomphaloides Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 25, pl. x, figs. 27-29.

Platyostoma cf. *euomphaloides* Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 97.

Description.—"Shell depressed subhemispheric; spire moderately elevated; volutions three or four, gradually enlarging from the apex—the last one expanded, not ventricose, with its exterior or periphery flat or slightly convex, and flattened or gently concave in the middle above; suture-line close. Aperture expanded, broadly subovoid; the inner lip has thickened callous, which projects in a prominent rim along the posterior border of the aperture. Surface marked by fine concentric striae, which are crowded in fascicles." Hall, 1879. A crushed specimen bearing considerable resemblance to this species occurs in the collection.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Subclass EUTHYNEURA

Order OPISTHOBRANCHIA

Suborder PTEROPODA

Family CAVOLINIIDAE

Genus STYLIOLINA Karpinsky

STYLIOLINA FISSURELLA (Hall)

Plate XXXVII, Figs. 17-20

Tentaculites fissurella Hall, 1843, Geol. N. Y., pt. iv, p. 180, figs. 9, 10 and p. 222, fig. 4.
Styliola fissurella Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 178, pl. xxxi A, figs. 1-28.
Styliola (*Styliolina*) *fissurella* Clarke, 1885, Bull. U. S. Geol. Surv., No. 16, p. 57.
Styliolina fissurella Clarke, 1891, Am. Geol., vol. viii, p. 88.
Styliolina fissurella Clarke, 1892, Am. Jour. Sci., 3d ser., vol. xliii, p. 58.
Styliolina fissurella Clarke, 1898, Fifteenth An. Rep. State Geologist [N. Y.], p. 54.
Styliolina fissurella Grabau, 1899, Bull. Buffalo Soc. Nat. Sciences, vol. vi, p. 282, fig. 214.
Styliolina fissurella Clarke, 1903, N. Y. State Mus., Bull. 65, p. 570.
Styliolina fissurella Clarke, 1904, N. Y. State Mus., Mem. 6, pt. 2, p. 342.
Styliolina fissurella Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 16, fig. 1229.

Description.—"Form an extremely slender, elongate cone, like the point of a small needle; apical portion of the tube solid; apex extremely minute, often bulbiform, and very gradually enlarging to the mouth. Surface often smooth and without any visible ornamentation, so far as can be determined; or with fine striae of growth, which are unequally developed on different parts of the shell; also with fine longitudinal striae, which may be present with or without transverse striae; usual length from one to two, sometimes two and a half, and rarely five millimeters." Hall, 1879.

The Maryland specimens are smooth impressions except that the larger ones show very faint remains of transverse striae and a longitudinal depressed line along the central part of the shell which is probably due to pressure. This species is noted only infrequently in the Maryland Hamil-

ton beds, although in the succeeding Portage beds it is of common occurrence. The distinguishing characters have been clearly stated by Professor Grabau as the "small size; needle-like form; minute, often bulbiferous apex; transverse and sometimes longitudinal striae; sharply depressed central fracture line in all the compressed specimens" (Bull. Buffalo Soc. Nat. Sciences, vol. vi, 1899, p. 282).

Length 1-3 mm.; width ½ mm. at mouth of specimen 3 mm. in length.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Tonoloway, Md.; Williams Road, 3½ miles east of Cumberland; B. & O. R. R. cut at 21st Bridge; Hanging Rock, W. Va.; W. Va. Cent. R. R. cut at 21st Bridge. MARCELLUS MEMBER. East of Oldtown. HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; west of iron bridge over Town Creek northeast of Oldtown; Licking Creek east of Warren Point; Ernstville.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Suborder CONULARIDA

Family TENTACULITIDAE

Genus TENTACULITES Schlotheim

TENTACULITES ATTENUATUS Hall

Plate XXXVII, Fig. 21

Tentaculites attenuatus **Hall, 1876, Illustrations Dev. Fossils: Pteropoda, pl. xxvi, figs. 19, 20.**

Tentaculites attenuatus **Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 170, pl. xxxi, figs. 19, 20.**

Tentaculites attenuatus **Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 11.**

Description.—"Form elongate-conical, regularly expanding from the apex, and with no evidence of becoming cylindrical towards the aperture. The apical portion of the shell is very finely marked by acute annulations for a distance of about two and a half millimeters, without visible intermediate striae; beyond this, toward the aperture, the annulations increase in distance, and the intermediate furrows are marked with one, two,

three or more fine, regular, transverse striae—the usual number on the larger part of the tube being four or five, but sometimes increased, in exceptionally wide spaces, on some individuals, to eight." Hall, 1879.

Hall gave the entire length of the fossil as ten to twelve mm., rarely a little more and stated that it occurred as casts and impressions of the exterior shell in argillaceous sandstone. He also said that in general character and details of surface-marking it was very similar to *T. bellulus* Hall, but differed in smaller size and in the irregularity in distance of the annulations. Among other localities it was reported from Saddleback Ridge, Huntingdon County, in southern central Pennsylvania.

A number of specimens which are identified as this species have been noted in arenaceous shales or thin-bedded sandstones in Maryland. They are mainly external impressions of the shell although occasionally a portion of the internal impression is preserved. The annulations occur at unequal distances between which, near the aperture, are from three to five clearly marked striae, but the number of striae decrease toward the apical end until near that extremity there are none. Near the aperture of the shell there are eight annulations in a distance of 5 mm. It is thought that the size, irregularity in distance of the annulations, number and occurrence of the transverse striae satisfactorily refer these specimens to *Tentaculites attenuatus.*

Length, of most complete specimen, about 10 mm., but the extremity is wanting; width, at aperture, 1½ mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. On National Road ½ mile west of Tonoloway Ridge; McCoys Ferry; southwest of McCoys Ferry; ¼ mile north of Green Spring Furnace.

Collection.—Maryland Geological Survey.

TENTACULITES BELLULUS Hall

Plate XXXVII, Figs. 22-25

Tentaculites bellulus Hall, 1876, Illustrations Dev. Fossils: Pteropoda, pl. xxvi, figs. 15-18.

Tentaculites bellulus Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 169, pl. xxxi, figs. 15-18, pl. xxxi A, figs. 48-51.

Tentaculites bellulus Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 11, fig. 1222.

Description.—Form extremely elongate-conical, slender, becoming more nearly cylindrical on approaching the mouth. The apical portion is extremely attenuate with regular and closely arranged acute annulations, which near the apex are visible only under a strong lens, and the extreme portion is apparently smooth, the distance between the annulations increases toward the mouth and fine transverse, lamellose striae develop in the interspaces. The usual length is from 15 to 22 mm., and the largest individuals have a diameter at the mouth of nearly 3 mm. This species is distinguished from *T. attenuatus* by its larger size and regularity in distance of the annulations.

Specimens longer than the preceding species with annulations at about a uniform distance apart, decreasing from the mouth toward the apex, the broader interspaces marked by fine transverse striae, are referred to this species.

Length, about 14 mm.; width, toward mouth, 1½ mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry; west of iron bridge over Town Creek northeast of Oldtown; on road about half way between Romney and Hanging Rock, W. Va.

Collections.—Maryland Geological Survey; American Museum of Natural History.

TENTACULITES BELLULUS VAR. POTOMACENSIS n. var.

Plate XXXVIII, Figs. 1-3

Description.—External impressions which are more robust and longer than the normal forms of *T. bellulus*. The annulations are not so acute and have a steep posterior slope with a more gradual anterior one, while there is a larger number of transverse striae on the interspaces and slopes of the annulations. The size and number of striae apparently distinguish it from the normal specimens of this species.

The specimen from McCoys Ferry was submitted to Dr. Grabau who wrote as follows: "I should be inclined to call it a variety of *T. bellulus* with some characters of *T. scalariformis*. Note the steeper posterior slopes of the annulations."

Length of preserved portion, 25 mm.; width, toward mouth, 3 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. McCoys Ferry; southwest of McCoys Ferry.

Collection.—Maryland Geological Survey.

Family CONULARIIDAE

Genus CONULARIA Miller

CONULARIA cf. UNDULATA Conrad

Plate XXXVIII, Fig. 4

Conularia undulata Conrad, 1841, 5th An. Rep. Pal. of N. Y., p. 57.
Conularia undulata Conrad, 1861, Hall: Descriptions of New Species of Fossils, etc., p. 34.
Conularia undulata Conrad, 1862, Hall: 15th An. Rep. N. Y. State Cab. Nat. Hist., p. 62.
Conularia undulata Conrad, 1876, Hall: Illustrations of Devonian Fossils: Pteropoda, pl. 5.

Description.—Form elongate-pyramidal, with a quadrangular base. Transverse section quadrangular, rhomboidal, with the faces subequal (equal ?); angles indented by the longitudinal grooves. Faces of the pyramid slightly convex in well preserved specimens, often entirely flat, or sometimes concave, the proportions modified from pressure; center of each face marked by a distinct shallow groove, along which there is a slight deflection of the transverse striae. Angles of the pyramid furrowed by a strongly marked groove, which is conspicuous in all conditions of the shell, and traversed by the surface-markings. Aperture of the fossil unknown. Summit truncated by a convex septum in the best preserved specimens. Shell extremely thin; in most of the specimens entirely dissolved.

Surface, as determined from the best preserved specimens, and from external moulds, marked by fine transverse striae, which, upon the sides, are gentle curving towards the aperture, and slightly recurved in crossing the median groove. the striae are interrupted by minute pustulose elevations, which give the surface, as seen under a strong lens, in its usual condition of preservation, a minutely crenulate or pustulose aspect. These elevations do not extend to the narrow interstriate spaces, which

are apparently quite smooth, and about twice as wide as the elevated striae, but vary with the growth and age of the shell. Hall, 1879.

The collection includes six fragmentary specimens of Conularia. These are all more or less completely flattened, making specific determination uncertain. One of the specimens at least is comparable with and probably identical with *C. undulata.*

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Genus ENCHOSTOMA Miller and Gurley

ENCHOSTOMA ? sp.

Description.—The collection contains specimens of a cylindrical rod-like fossil about 1 mm. in diameter occurring in an earthy limestone. The specimens represent only fragments rather less than 1 inch in length composed of hard chitinous material. That these have had a considerable length is indicated by the barely perceptible amount of tapering seen in the individual specimens. Provisionally these may be referred to *Enchostoma.*

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Family TORELLELLIDAE

Genus COLEOLUS Hall

COLEOLUS TENUICINCTUS Hall

Plate XXXVIII, Figs. 5-8

Coleoprion tenuicinctum Hall, 1876, Illustrations Dev. Fossils: Pteropoda, pl. xxvii, figs. 1-4.

Coleolus tenuicinctum Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 185, pl. xxxii, figs. 5-9, pl. xxxii A, figs. 6-10.

Coleolus tenuicinctum Grabau, 1899, Bull. Buffalo Soc. Nat. Sciences, vol. vi, p. 284, fig. 217.

Coleolus tenuicinctum Kindle, 1901, Twenty-fifth An. Rep. Dept. Geol. & Nat. Res. Indiana, p. 735, pl. xxiii, figs. 6, 7.

Coleolus tenuicinctus Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 9, fig. 1219b.

Description.—" Shell an extremely elongate, gradually and regularly tapering cone; having in the largest individuals, a diameter of six millimeters at the larger extremity, with a length of seventy-five millimeters. Surface marked by fine closely arranged striae, or frequently with more distant oblique annulations, receding from the aperature, or sinuate on the ventral side; interrupted longitudinal striae are visible in well preserved specimens." Hall, 1879.

Hall also stated that the specimens were generally in a crushed condition and showed a line of fracture which may be mistaken for a longitudinal groove while the diameter and length vary to a considerable degree and no individual in the Hamilton shales has yet been found entire. Dr. J. M. Clarke has shown the presence of septa in another species described by Hall as *Coleolus aciculum* and hence referred it to the genus *Bactrites* (Am. Geol., vol. xiv, 1894, p. 37, pl. ii, fig. 9); but so far as we are aware this character has not yet been observed in *C. tenuicinctum* and therefore the species is left in the genus *Coleolus*.

The Maryland specimens are contained in an arenaceous shale and are long tapering cones which are flattened with a conspicuous longitudinal groove due to fracture. The more or less oblique annulations are well shown, but the concentric and longitudinal striae, very imperfectly. The specimens, however, are practically identical with many of this species which the writer has collected and examined from the Hamilton shales and there can be no question regarding their specific identity.

Length of two longest specimens, which are broken and do not show complete length, 55 and 60 mm.; width of both at larger extremity, 6 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; west of Lock No. 56 at Great Cacapon.

Collection.—Maryland Geological Survey.

CLASS CEPHALOPODA

Subclass TETRABRANCHIATA

Order NAUTILOIDEA

Suborder ORTHOCHOANITES

Family ORTHOCERATIDAE

Genus ORTHOCERAS Breynius

ORTHOCERAS BEBRYX Hall (?)

Plate XXXVIII, Figs. 10, 11

Orthoceras bebryx Hall 1876, Ill. Dev. Fossils: Cephalopoda. Explanation pl. xxxix, figs. 1, 2.
Orthoceras bebryx Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 275, pl. xxxviii, fig. 10; pl. xxxix, fig. 2; pl. lxxxiii, fig. 14; pl. lxxxiv, figs. 11, 12.
Orthoceras bebryx Clarke, 1903, N. Y. State Mus., Bull. 65, p. 618.

Description.—Shell robust, straight, regularly enlarging from the apex; transverse section, allowing for the degree of compression, subcircular. Living chamber not fully observed; air-chambers regular, increasing in depth from the apex, and varying in different individuals from six to ten mm. Septa smooth and thin, so far as observed; sutures, in specimens not distorted by compression, straight and horizontal; siphuncle moniliform, expanding between the septa, and having a diameter equal to, or two-thirds of, the depth of the air-chambers, the position is probably slightly eccentric. The test has not been preserved but the casts of the interior indicate a transversely lamellose-striate surface. A fragment, embracing a portion of the chamber of habitation and seventeen of the adjacent air-chambers, has a length of 220 mm.

Several fragments of a large *Orthoceras* occur in the Maryland Collection, which probably belong to this species. They are mostly internal impressions, and the one figured shows apparently part of the living chamber and six air-chambers which vary in depth from 6½ to 9 mm. Another specimen shows a large chamber of habitation, which is flattened by crushing; while an external impression of a large specimen which

appears to be closely related to *O. bebryx,* if not identical, shows transverse striae crossed by longitudinal ones giving the surface a reticulated appearance somewhat similar to that of *O. linteum* Hall.

Length of living chamber, 59 mm.; width near larger end, 48 mm.; length of six air-chambers following chamber of habitation of another specimen, 50 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Oldtown Road near Cumberland; west of Lock No. 56 at Great Cacapon; on Oldtown Road east of Maryland Ave., Cumberland; on road east of Pine Hill about 4 miles north of Oldtown.

Collection.—Maryland Geological Survey.

ORTHOCERAS SUBULATUM Hall (?)

Plate XXXIX, Figs. 1, 2

Orthoceras subulatum Hall, 1843, Geol. N. Y., pt. iv, p. 180, fig. 1.
Orthoceras subulatum Rogers, 1858, Geol. Penna., vol. ii, p. 826, fig. 654.
Orthoceras subulatum Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 77.
Orthoceras subulatum Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 283, pl. xxxviii, fig. 3; pl. lxxxiv, figs. 1, 2, 4, 6-10; pl. lxxxvi, figs. 1, 2.
Orthoceras subulatum Grabau, 1899, Bull. Buffalo Soc. Nat. Sciences, vol. vi, p. 288, fig. 221 on p. 287.
Orthoceras subulatum Clarke, 1903, N. Y. State Mus., Bul. 65, p. 641.
Orthoceras (*Geisonoceras*) *subulatum* Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 52, fig. 1252b.

Description.—Shell straight, regularly enlarging from the apex nearly to the aperture; transverse section circular. Living chamber well developed, having a length equal to about three times its diameter at the last septum, regularly expanding to a point near the aperture where it is slightly contracted; air-chambers numerous, increasing in depth from the apex to the outer chamber, where the depth is about 3 mm. Septa smooth and thin; siphuncle small and subcentral. Test thin, surface marked by very fine, irregular, lamellose striae of growth; some of the specimens show longitudinal striae, and more rarely very fine, filiform, longitudinal markings. The internal mould is essentially smooth, specimens from the softer shales often presenting a black and polished appearance; the indi-

viduals never reaching a large size, nearly entire examples have a length of from 85 to 130 mm.

The Maryland specimens are fragmentary and very imperfectly preserved; but smooth internal molds and fragments of external impressions with the outline and markings of this species have been referred to it. On comparison they were found to agree fairly well with specimens labeled as this species which are in the office of the State Paleontologist of New York; while the smooth, internal impression of a living chamber which is figured was submitted to Dr. J. M. Clarke, who reports that it is probably safe to refer it to *O. subulatum* Hall rather than *O. constrictum* Van., since the constriction is wanting which is the most important difference between the two species.

The longest fragment in the collection has a length of 60 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland. HAMILTON MEMBER. On W. Va. side Potomac River 3 miles south of Cumberland; on road about half way between Romney and Hanging Rock, W. Va. (?).

Collection.—Maryland Geological Survey.

ORTHOCERAS CONSTRICTUM Vanuxem

Plate XXXIX, Figs. 5-8

Orthoceras constrictum Vanuxem, 1842, Geol. N. Y., pt. iii, p. 152, fig. 1.
Orthoceras constrictum Hall, 1862, Fifteenth Rep. State Cab. Nat. Hist., p. 77.
Orthoceras constrictum Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 288, pl. lxxxiv, figs. 13, 14, 16; pl. lxxxv, figs. 5, 10, 11, 13.
Orthoceras constrictum Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Orthoceras constrictum Clarke, 1903, N. Y. State Mus., Bull. 65, p. 621.
Orthoceras constrictum Clark and Mathews, 1906, Md. Geol. Surv., vol. vi, pl. xvii, fig. 14.
Orthoceras constrictum Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 51, fig. 1251.

Description.—Shell straight, regularly enlarging from the apex to the chamber of habitation; transverse section circular. Living chamber cylindrical, well developed, having a length equal to four times the diameter at the last septum; anterior to the middle there is a very broad, gentle constriction, which, in its position and strength, varies considerably, some-

times becoming a very conspicuous feature; air-chambers numerous, regular, with a depth of from two to three mm. Septa smooth and thin; sutures straight and horizontal; siphuncle central. Test not preserved but some of the impressions show traces of lamellose striae of growth; the internal impression of the chambers is smooth, with the sutures but little impressed. This species is distinguished from *O. subulatum* by its constricted and much more developed chamber of habitation; in the depth of the air-chambers and the position of the siphuncle the two species are very similar; it is further removed from *O. exile* by the depth of the air-chambers and its central siphuncle.

This species is represented in the Maryland Collection by a single fragment of a living chamber from the Oldtown Road near Cumberland; but the characteristic constriction is well shown and there is apparently no question but that it belongs to this species. Hall also reported the species at Cumberland, Md.[1] Later, additional specimens were obtained from other localities.

Length of the preserved part of the chamber of habitation, 38 mm.; width, about 19 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Oldtown Road near Cumberland; east bank Evitts Creek below Wolfe Mill (?); on Oldtown Road east of Maryland Ave., Cumberland; on road 1 mile north of Romney, W. Va. (?); W. Va. side Potomac River about 3 miles south of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

ORTHOCERAS cf. EXILE Hall

Plate XXXIX, Fig. 9

Orthoceras exile Hall, 1861, Desc. New Species of Fossils, etc., p. 50.
Orthoceras exile Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 78. pl. viii, fig. 5.
Orthoceras exile Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 290, pl. xxxix, fig. 3; pl. lxxxiv, fig. 3; pl. lxxxv, figs. 1, 2, 14, 15.
Orthoceras exile Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.

[1] Pal. N. Y., vol. v, pt. ii, p. 289.

Orthoceras exile **Grabau, 1899, Bull. Buffalo Soc. Nat. Sci., vol. vi, p. 288, fig. 222 on p. 287.**
Orthoceras exile **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 625.**
Orthoceras exile **Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 52, fig. 1252a.**

Description.—Shell straight, slender, regularly and gradually enlarging from the apex; transverse section circular. Living chamber cylindrical, large, length equal to more than three times the diameter at the last septum; air-chambers numerous, increasing in depth toward the outer chamber, varying from two or three mm. to five mm. in the length of 100 mm., or about thirty chambers. Septa smooth and thin; sutures straight and horizontal; siphuncle eccentric, distant from the nearest point on the walls of the air-chambers about one-third the diameter of the tube. Test and surface markings not observed; internal mold smooth, showing no traces of the surface markings. This species differs from *O. constrictum* and *O. subulatum* in its eccentric siphuncle and more distant septa; while the septa are comparatively more frequent than in *O. telamon* and *O. emaceratum,* and the siphuncle is smaller and less eccentric than in the former.

The Maryland specimens which are compared with this species are all fragmentary and part of them greatly flattened by crushing, so that the material scarcely admits of accurate specific identification. The depth of the air-chambers, however, varies from 3½ to 4 mm. and the siphuncle is eccentric, characters which agree with those of *O. exile.* Prof. Hall reported this species from Hamilton rocks at Cumberland, Maryland.[1]

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill.

Collection.—Maryland Geological Survey.

ORTHOCERAS TELAMON Hall (?)

Plate XL, Figs. 1-4

Orthoceras telamon **Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 291, pl. lxxxv, figs. 3, 4, 12.**
Orthoceras telamon **Grabau, 1899, Bull. Buffalo Soc. Nat. Sciences, vol. vi, p. 289, fig. 223 on p. 288.**
Orthoceras telamon **Clarke, 1903, N. Y. State Mus., Bull. 65, p. 642.**

[1] Pal. N. Y., vol. v, pt. ii, p. 291.

Description.—Shell straight, regularly and gradually enlarging from the apex; transverse section circular. Living-chamber cylindrical, well developed, having a length about three times the diameter of the tube at the last septum, and without any marked constriction or expansion toward the aperture; air-chambers regular, having a depth of five mm. where the diameter of the tube is nine mm., and of eight mm. where the diameter is twenty mm. Septa apparently smooth and thin, the margins sometimes slightly thickened, and with a concavity equal to an arc of about 110°; sutures straight, and somewhat oblique in a dorso-ventral direction; siphuncle large, eccentric, less than one-third the diameter of the tube from the ventral walls, with a diameter of two mm. where the tube measures twenty mm. in diameter, and diminishing but slightly toward the apex. Test and surface markings not preserved; internal mold smooth with the exception of a low, longitudinal ventral carina. This species is distinguished from *O. exile* by the carina on the internal mold, the comparatively deeper air-chambers, and the more eccentric position of the siphuncle; it also closely approaches *O. emaceratum* in several features, but the septa are a little more frequent.

The specimens in the Maryland Collection referred to this species are broken and not very satisfactory for identification; but one shows five air-chambers or camerae each of which has a depth of five mm. and another large internal impression of a living chamber shows in the septum at its base the siphuncle which is very eccentric, considerably more so than it is represented in the figure of *O. exile* and agreeing with that of *O. telamon*.[1] These specimens were submitted to Dr. J. M. Clarke who wrote as follows concerning them: "These specimens have rather deeper camerae and a more cylindrical body chamber than *O. exile,* in these respects approaching more nearly *O. telamon* H."

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Robinsons Farm 2 miles south of Patterson Depot, W. Va.

Collection.—Maryland Geological Survey.

[1] Pal. N. Y., vol. v, pt. ii, pl. 85, figs. 2 and 4.

ORTHOCERAS EMACERATUM Hall (?)

Plate XL, Fig. 7

Orthoceras emaceratum Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 170, pl. viii, fig. 7.

Orthoceras emaceratum Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 292, pl. xxxix, fig. 4; pl. lxxxv, fig. 16.

Orthoceras emaceratum Grabau, 1899, Bull. Buffalo Soc. Nat. Sciences, vol. vi, p. 290, fig. 225 A on p. 289.

Orthoceras emaceratum Clarke, 1903, N. Y. State Mus., Bull. 65, p. 624.

Description.—Shell straight, slender, gradually enlarging from the apex; transverse section subcircular. Living-chamber not seen; air-chambers regular, gradually increasing in depth toward the living-chamber, varying from six to nine mm. in the length of eighty mm. Septa and siphuncle unknown; sutures straight and horizontal. Test not preserved, but some specimens show traces of transverse striae; internal mold smooth, with the sutures but little impressed. One fragment, with twenty air-chambers, has a length of 125 mm., with a diameter at the smaller end of ten mm. The distinguishing characters are the depth of the chambers, compared with the diameter of the tube, and the small apical angle. In its general aspect and association it is similar to *O. aulax;* but the marked surface ornaments on the latter species, which are also shown on the internal mold, are characteristic.

In the Maryland Collection is a single flattened internal impression which probably belongs to this species. Five air-chambers and a portion of the sixth are shown which vary in depth from 6 to 6½ mm. This specimen was examined by Dr. Rudolph Ruedemann, who wrote as follows concerning it: "This is *O. emaceratum* Hall, distinguished by its small apical angle and great depth of the air-chambers."

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. W. Va. side Potomac River 3 miles south of Cumberland.

Collection.—Maryland Geological Survey.

ORTHOCERAS cf. AULAX Hall

Plate XL, Fig. 8

Orthoceras aulax Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 293, pl. lxxxiv, fig. 18.

Orthoceras aulax Grabau, 1899, Bull. Buffalo Soc. Nat. Sciences, vol. vi, p. 289, fig. 224 on p. 288.

Orthoceras aulax Clarke, 1903, N. Y. State Mus., Bull. 65, p. 618.

Description.—" The tube is slender and the enlargement very gradual. Air-chambers, septa and siphuncle unknown. Surface marked by regular, numerous, low, rounded transverse ridges, about twelve in the space of ten mm.; the interspaces, or furrows, are regularly concave, and have a width equal to the ridges; portions of the surface also show that it was traversed by fine, sharp, longitudinal striae, crossing the ridges." Hall, 1879.

The Maryland specimen is apparently a fragment of the living chamber 80 mm. in length which is marked by transverse ridges and furrows with 10 to 12 ridges in the space of 10 mm., and in appearance very similar to those represented on the figure of this species in the Palæontology of New York.[1]

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Road east of Pine Hill about 4 miles north of Oldtown.

Collection.—Maryland Geological Survey.

Family KIONOCERATIDAE

Genus SPYROCERAS Hyatt

SPYROCERAS CROTALUM (Hall)

Plate XLI, Figs. 1-5

Orthoceras crotalum Hall, 1861, Descriptions of New Species of Fossils, etc., p. 50.

Orthoceras crotalum Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 78.

Orthoceras crotalum Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 296, pl. xliii, figs. 1-9, 11, 12; pl. lxxxii, figs. 1-6; pl. cxiii, fig. 13.

Spyroceras crotalum Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.

Orthoceras (Spyroceras) crotalum Clarke, 1903, N. Y. State Mus., Bull. 65, p. 622.

Spyroceras crotalum Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 64.

Description.—Shell straight, regularly and rapidly enlarging from the apex, and becoming cylindrical toward the aperture; transverse section subcircular. Living-chamber small, cylindrical; length about two and a

[1] Vol. v, pt. ii, pl. 84, fig. 18.

half times the diameter at the last septum; aperture entire, without special contraction or expansion; air-chambers regular, numerous, more frequent than the annulations; with a depth of about three mm. Septa smooth and thin; sutures straight and horizontal, and bearing no uniform relation to the frequency or curvature of the annulations; siphuncle subcentral. Test very thin, rarely preserved; tube ornamented with prominent annulations, which become more frequent and less marked toward the apex; on the chamber of habitation the annulations are very sharp and elevated, often curved and oblique; the tube, for a distance of twenty mm. or more back of the aperture, is cylindrical and without annulations, but is marked by lamellose lines of growth. Surface marked by fine, regular, sharp, continuous longitudinal striae, crossed by finer, crowded, irregular striae, about fifteen to twenty longitudinal striae in the space of two mm.; the internal mold is essentially smooth, with the exception of the prominent annulations. This species is distinguished from *S. nuntium* by its more prominent and less frequent annulations and from *S. caelamen* by its continuous sharp, longitudinal striae and more elevated annulations.

The Maryland Collection contains a single, small and broken specimen labeled simply Western Maryland, which apparently belongs to this species. It is marked by similar prominent annulations and about the same distance apart, 6 mm. on this specimen, while the air-chambers are about 3 mm. apart, more frequent than the annulations and marked by continuous longitudinal striae. It agrees well with specimens in the office of the State Paleontologist of New York which are labeled this species, as well as with a portion of one of the type specimens.[1] Later, additional specimens were collected from the localities named below.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Western Maryland; Ernstville; W. Va. side Potomac River about 3 miles south of Cumberland; on road 1 mile north of Romney, W. Va. (?).

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

[1] Pal. N. Y., vol. v, pt. ii, pl. 82, fig. 1.

SPYROCERAS NUNTIUM Hall

Plate XLI, Figs. 6-8

Orthoceras nuntium Hall, 1861, Descriptions of New Species of Fossils, etc., p. 51.

Orthoceras nuntium Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 79, pl. viii, figs. 3, 4.

Orthoceras nuntium Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 299, pl. xliii, figs. 4-10, 13, 14; pl. lxxxii, figs. 14, 15.

Orthoceras nuntium Grabau, 1899, Bull. Buffalo Soc. Nat. Sci., vol. vi, p. 290, fig. 225 on p. 289.

Orthoceras (*Spyroceras*) *nuntium* Clarke, 1903, N. Y. State Mus., Bull. 65, p. 633.

Spyroceras nuntium Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 64, fig. 1272.

Description.—Shell straight, regularly and rapidly enlarging from the apex; transverse section subcircular. Air-chambers regular, numerous, having a depth of 2 mm. where the tube has a diameter of 10 mm., and are of about the same frequency as the annulations. Septa smooth, with a concavity equal to more than the depth of the adjacent air-chambers; sutures straight and horizontal, essentially corresponding to the annulations; siphuncle subcentral, moniliform. Test very thin, rarely preserved; tube ornamented with regular, numerous, horizontal annulations. Surface marked by regular, fine, thread-like, longitudinal striae, which are crossed by finer, less prominent lines of growth; the longitudinal striae are usually continuous, but are occasionally interrupted by the lines of growth, of which there are about twelve in the space of two mm.; on the internal mold the striae are usually impressed, but they appear as if rounded and continuous, and do not present the sharp, threadlike character as on the interior. A large fragment has a length of 140 mm., and shows forty-two annulations; portions of smaller individuals show from four to six annulations in the length of ten mm., varying with the diameter of the tube. This species is distinguished from *S. crotalum* by its more frequent and less prominent annulations, and by the somewhat coarser longitudinal striae; while it differs from *S. caelamen* in not having the longitudinal striae rounded and often interrupted by lamellose lines of growth.

There is a single broken specimen in the Maryland Collection which is 26 mm. in length, 17 mm. wide and shows six annulations which are about 3 mm. apart, not so strong and distant as those of *S. crotalum*, but similar to the figures of *S. nuntium*. A bit of the test is preserved at one end showing the fine, thread-like longitudinal striae, which alternate slightly in size as is stated to be the case for at least some specimens of this species,[1] with ten to twelve in a space of two mm., crossed by finer transverse striae.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. W. Va. side Potomac River 3 miles south of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

SPYROCERAS CLARKEI n. sp.

Plate XLI, Figs. 9-11

Description.—An annulated broken, compressed specimen which has a total length of about 60 mm., and diameter of about 22 mm., showing three annulations on one side and five on the other, is referred to this genus. The annulations are broadly rounded, about 10 mm. vertically from the center of one to the center of the adjacent one and separated by a broad, rounded sinus. Surface marked by distinct, raised, uniform, continuous longitudinal striae which are crossed by regular concentric striae of nearly the same strength, forming a slight node at the point of intersection, both at about the same distance apart so that the surface is composed of squares or rectangles with a height and width of about 1 mm., inside of which on part of the surface are faint vertical and concentric striae which are perhaps due to crushing.

This species is somewhat similar to *Spyroceras geneva* Clarke from the Onondaga limestone of New York;[2] but it differs in having a more slender tube, much broader sinus between the annulations and longitudinal and concentric striae of nearly equal strength, instead of the longitudinal

[1] Pal. N. Y., vol. v, pt. ii, pl. 43, explanation of fig. 7.

[2] 13th An. Rep. State Geologist [N. Y.], 1894 [1895], p. 168, pl. 2, figs. 5-7.

being much stronger as in *S. geneva*. In general appearance and surface markings it is very similar to some specimens of the Dictyospongidae and the writer at first regarded it as a new species of the genus *Ceratodictya* and related to *C. annulata* (Hall).[1] The specimen, however, was later sent to Dr. J. M. Clarke, in whose honor the specific name is given, who referred it to the genus *Spyroceras* and this identification is accepted by the writer. Dr. Clarke wrote the following note concerning this specimen: "Notwithstanding the remarkable similarity between this specimen and the typical forms of the dictyosponge, *Ceratodictya* (*C. annulata* and *C. centeta*) the characters of the exterior lead me to the conviction that it is not a sponge but an *Orthoceras*. These features favor this view: the longitudinal ridges are too regularly continuous and equidistant and they are caught up slightly where crossed by the concentric lines. Interstitial lines almost fail except where developed by compression. In a sponge these should be as evident as the major lines. The prevailing ornament in *Orthoceras* of the *Dawsonoceras* and *Spyroceras* types approaches very closely the reticulation of a dictyosponge; but compare with this specimen my *Orthoceras* (*Spyroceras*) *geneva* (Onondaga limestone) in 13th Rept. N. Y. Geologist."

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Ernstville.

Collection.—Maryland Geological Survey.

Suborder CYRTOCHOANITES

Family PHRAGMOCERATIDAE

Genus GOMPHOCERAS Sowerby

Cf. GOMPHOCERAS PINGUE Hall

Plate XLII, Figs. 1, 2

Gomphoceras pingue Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 346, pl. xciv, fig. 9; pl. xcv, fig. 6.

Gomphoceras pingue Clarke, 1903, N. Y. State Mus., Bull. 65, p. 593.

Description.—*Gomphoceras pingue* was described by Hall as follows: "Shell small, gibbous, slightly arcuate; transverse section very broadly

[1] 15th An. Rep. State Geologist [N. Y.], vol. ii, 1898 [1899], p. 860, pl. 22, figs. 3-6.

oval or subcircular; point of greatest gibbosity posterior to the middle of the living-chamber; apical angle about 30°. Living-chamber gibbous, with the sides convex, and sloping gradually to the aperture; crenulated band not well defined, but the markings are preserved over the cast of the walls of the air-chambers as broad, shallow, longitudinal furrows. Air-chambers regular, having a depth of about 4 mm.; septa smooth, moderately concave; sutures, in uncompressed specimens, straight and horizontal. Test and surface markings unknown; internal mold smooth, with the exception of the crenulations over the walls of the air-chambers; sutures but slightly impressed. A fragment embracing a portion of the living-chamber, with five attached air-chambers, has a length of 50 mm.; of which about 30 mm. pertain to the grand chamber, which has a greatest transverse diameter of 40 mm."

The Maryland specimen is apparently part of a living-chamber with a length of about 72 mm. and width of 58 mm., which is slightly arcuate, quite convex, sides sloping and siphuncle eccentric.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Western Maryland.

Collection.—Maryland Geological Survey.

Order AMMONOIDEA

Suborder MICROCAMPYLI

Family BACTRITIDAE

Genus BACTRITES Sandberger

BACTRITES ACICULATUS (Hall)

Plate XLII, Fig. 4

Dentalium aciculatum Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 107.

Coleolus (Dentalium (?)) aciculatum Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 190, pl. xxxii A, figs. 17, 18.

Description.—" Form slender, elongate, cylindrical, tubular, very gradually attenuating from the base; surface striated (?). The specimens under examination are several fragments of longer tubes, but there

are no entire examples. Some of these are very slightly curved while others are entirely straight, and it is possible that the curvature may be due to accident. From the specimens examined no satisfactory determination of the surface markings can be made." Hall, 1879.

The Maryland specimens are slender, gradually tapering and perfectly smooth, with the exception perhaps of one suture near the larger end of the specimen figured, the longer one with a length of 22 mm. The specimen was sent to Dr. J. M. Clarke who has written as follows: "With regard to the specimen called *Coleolus aciculatus* I might say that for myself I do not know what *Coleolus* really is. So far as my observations of specimens of this object are concerned they seem to be forms of *Bactrites*. *Coleolus aciculum* is certainly that, and I am inclined to think that when Professor Hall described *C. aciculatum* he confused the species with what he had previously described as '*Orthoceras acicula*' from the Genesee shale. Miller, I observe, cites *C. aciculatus* from the Marcellus and Portage; *C. acicula* from the Genesee. Now the type of *Coleolus* is *C. tenuicinctus*, in which I have never seen any septa, but the species having the external aspect of this with full concentric ornament, mostly prove to be *Bactrites*. As to the identity of your specimen with Hall's *Dentalium aciculatum* I should have little question."[1]

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. W. Va. Cent. R. R. cut at 21st Bridge.

Collection.—Maryland Geological Survey.

BACTRITES ACICULUM Hall

Plate XXXVIII, Fig. 9; Plate XLII, Fig. 5

Orthoceras aciculum **Hall, 1843, N. Y. Geol. Survey, Fourth Geol. Dist., p. 243.**
Coleolus aciculum **Hall, 1879, Nat. Hist. N. Y. Pal., vol. v, pt. ii, p. 187; p. 32A, figs. 11-15 (16 ?).**
Bactrites aciculum **Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 104, pl. ix, fig. 3.**

Description.—" Fossil extremely elongate, cylindro-conical, having in the large specimens a diameter at the base (in its flattened condition) of

[1] Letter of March 28, 1903.

about 7 mm., with a length of more than 3 inches, becoming extremely slender and attenuate towards the apex. These fossils usually appear to have been subjected to maceration in the muddy sediment, and seldom preserve any indication of surface markings. There are rare examples, which present some evidence of obscure annulations or striae." Hall, 1879.

This fossil occurs on the surface of slabs of dark or drab shale as flattened acicular cones destitute of surface markings.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles east of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Family NAUTILINIDAE

Genus AGONIATITES Meek

AGONIATITES EXPANSUS (Vanuxem)

Plate XLII, Fig. 6

Goniatites expansus Vanuxem, 1842, Geol. N. Y., pt. iii, p. 146, fig. 1 (non von Buch).
Goniatites expansus Hall, 1860, Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 96, figs. 1, 2.
Goniatites vanuxemi Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 434, pls. lxvi-lxviii; pl. lxix, figs. 3-6; pl. cix, figs. 7, 8.
Goniatites vanuxemi Hall, 1888, Pal. N. Y., vol. v, pt. ii, Supplement, p. 39, pl. cxxvii, figs. 3-6.
Agoniatites expansus Clarke, 1901, N. Y. State Mus., Bull. 49, pp. 124, 125.
Agoniatites expansus Clarke, 1903, N. Y. State Mus., Bull. 65, p. 573.
Agoniatites expansus Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 135, fig. 1388.

Description.—Shell large, discoid, flattened on the sides and upon the periphery in its advanced stages of growth; volutions of the spire about three to four in specimens of smaller and medium size, and not determined in the larger ones; umbilicus large and open, exposing all the volutions of the spire. Living-chamber extremely large, occupying fully two-thirds of the last volution, with capacity at least four times as great as all the air-chambers together. Septa deeply concave, and with some exceptions, regularly increasing in distance toward the outer chamber,

in mature specimens they are ten or twelve mm. distant from each other, and in the extremely large specimens more than fifteen mm. distant; their concavity greater than the depth of the air-chambers; siphuncle is well defined at the septa, close to the ventral side, and distinctly circular in section. Test one to two mm. thick on the outer chamber of older individuals, and about half as thick in the smaller ones; the surface marked by strong, lamellose, curving striae, which in the young shells are crowded into fascicles, rising into ridges, and these curving annulations are sometimes indicated, on the cast of the living-chamber of the young shell, by low undulations. The striae, on the lateral faces, make a curvature very nearly corresponding to the curvature of the septa; and in the young shells they make an abrupt retral curve over the low saddle, thence to the middle of the periphery, where they are recurved, forming a deep sinus upon the ventrum; the place of the saddle is indicated by a double revolving groove, margined on each side by a low carina, and separated by a stronger similar one; as the shell enlarges, the lateral of these two grooves first becomes obsolete, and finally also the other, leaving a simple obtuse angle along the line of the saddle, over which the striae in their retral curve are more conspicuous. The individuals of this species present a great range in size and proportions; the smaller specimens do not exceed thirty mm. in their greatest dimensions, while many specimens have a greatest diameter of 150 to 200 mm. and one specimen has a diameter of over 300 mm.

Fragments of a fairly large specimen were obtained in the limestone lentil in the West Virginia Central Railroad cut at 21st Bridge, which are mostly smooth internal impressions and are scarcely well enough preserved for illustration. One fragment shows the inside of the shell and where it is exfoliated curving striae similar to those represented in figures of medium sized specimens of this species. The best specimens were shown Dr. J. M. Clarke who identified them as *Agoniatites expansus* (Vanuxem) and later in commenting upon a specimen of *Bactrites aciculatus* (Hall) embedded in a portion of the limestone which also contained a fragment of this shell he wrote: "Of additional interest to me is the fragment of large *Goniatite* on the reverse of this

specimen, which makes the rock look particularly like our Agoniatite limestone." The Agoniatite limestone is found in the lower part of the Marcellus shale in New York extending geographically from Schoharie County on the east to about the meridian of Phelps, Ontario County, on the west. Stratigraphically as described by Dr. Clarke it descends in the shale toward the west from a horizon in the east fifty feet above the summit of the Onondaga limestone until it reaches and probably enters that limestone.[1] The occurrence of a similar lithologic limestone in Maryland in the upper part of the black Onondaga shales, which also contains the characteristic Goniatite of the New York limestone—*Agoniatites expansus* (Vanuxem)—is an interesting fact.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. B. & O. R. R. cut at 21st Bridge; W. Va. Cent. R .R. cut at 21st Bridge; Williams Road, 3½ miles southeast of Cumberland.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Suborder EURYCAMPYLE

Family MAGNOSELLARIDAE

Genus PARODICERAS Hyatt

PARODICERAS DISCOIDEUM (Conrad)

Plate XLII, Figs. 7, 8

Goniatites discoideus Hall, 1860, 13th An. Rep. N. Y. State Cab. Nat. Hist., p. 97, figs. 4-6, p. 98.

Goniatites discoideus Hall, 1879, Nat. Hist. N. Y. Pal., vol. v, pt. ii, p. 441, pl. 71, figs. 1-13; pl. 74, figs. 4-5.

Description.—"Shell depressed orbicular in the young state, becoming discoid in its advancing growth and varying conditions of preservation. In young shells the transverse and lateral diameters are about as 5 to 10, 11 to 20, and 12 to 24; in a medium-sized specimen, preserving its natural proportions, the two diameters are as 17 to 46. A specimen, which is perhaps somewhat compressed, has a lateral diameter of 60 mm., with a

[1] Bull. N. Y. State Mus., No. 49, 1901, p. 137.

transverse diameter of 20 mm. The later faces curve rapidly in young shells, and in older ones are very gently curving toward the periphery, which is abruptly rounded.

"Volutions about four, embraced within the outer one, having the umbilicus closed exteriorly, and with a slight depression, which does not expose the inner whorls; somewhat gradually expanding in the young shell and more rapidly in the older ones. Transverse section, semi-elliptical with the base, deeply concave from the inclosed preceding volution. The increase in width of the last volution, in young, well-formed shells, is from 8 to 15 mm. In a large form it is from 14 to 28 mm., and in a specimen of 65 mm. in its greatest diameter, the increase in the last volution is from 25 to 40 mm., while the largest specimen measured, which is much compressed and somewhat distorted, gives 32 and 60 mm. as the diameters of the base of the last volution and that at the aperture.

"Chamber of habitation very large, having an area four times as great, and a capacity eight or ten times as great as all the air-chambers. Aperture, in old shells, elongate-semielliptical, with the base deeply indented by the embraced volution; toward the base the margin is laterally expanded, and distinctly auriculated at the baso-lateral angles; thence curving rapidly forward, it is again depressed anterior to the middle of the lateral face, forming a shallow sinus; whence it advances on the ventro-lateral portions, and, abruptly curving backward, forms a deep sinus on the periphery. Air-chambers very shallow near the axis of the shell, continuing nearly parallel, and then becoming rapidly expanded toward the periphery, gradually increasing in depth with the increasing size of the volutions.

"The septa, on each side, are closely arranged on the inner half of the volution, and first curve gently forward, and thence abruptly recurving on the middle of the lateral face, continue with a more gentle retral bend to the periphery, where they are more than three or four times as distant as at their origin. In their passage, they describe a broad and deep lateral lobe, which occupies the outer half of the volution; with a very shallow and scarcely marked saddle upon the peripheral border, and a very short and narrow, ventral lobe. In young shells the sides of the ventral lobe are

nearly parallel, and extend about one-third of the distance across the adjacent air-chamber. The width of the saddle is equal to the width of the lobe, and the depth of the lobe is equal to one and a half or two air-chambers. The sutures are distinctly marked upon the exterior of the cast by the thickened margins of the septa, which are imbricating toward the outer chamber, and leave a strong groove when weathered.

"Siphuncle very small, close to the ventral side, and nearly coincident with the walls of the peripheral lobe. In one specimen, having its greatest lateral diameter of 28 mm., the width of the volution at the last septum is 7 mm., and the diameter of the siphuncle about 1 mm. on the convex side of the septum. In a specimen exposing the siphuncle between several of the septa, its form is evidently subconical, narrower at the concave face, and wider at the convex face of the septum.

"The test is very thin, in young specimens being not more than .2 mm., and in older ones not more than .5 mm. The older shells are always extremely compressed. The surface is marked by fine, closely arranged striae, which at intervals are raised in fascicles, giving an undulated aspect, which is often more conspicuous in young than older shells. The striae become more conspicuous as they pass from the lateral faces over the borders of the periphery. There are other fine, gently undulating, concentric striae, which are confined to a small area around the umbilicus, giving a delicately ornamented surface. Some of the specimens show a pitted or punctated surface, of similar character to that observed on the shell of the recent Nautilus beyond the covering of the mantle. The principal striae make an abrupt retràl bend upon the ventro-lateral margins, and describe a deep sinus upon the periphery.

"The internal cast, in a large proportion of the specimens, is essentially smooth, being marked only by impressions of the striae of growth, and in a few examples by gentle undulations, which indicate the course of the stronger fascicles of the external striae. The marks of the undulating concentric striae around the umbilicus are rarely preserved in the casts of the interior, but the punctate marking is more frequently seen. Small individuals of this species have a lateral diameter of 10 mm., with a transverse diameter of 6 mm. The largest specimen measured, which is

much compressed in the softer shales, has a greatest diameter of 95 mm. The prevailing forms are illustrated on plate 71. The natural rotundity of the young and medium-sized specimens is illustrated in figures 5, 6, 8, and 9 of the same plate.

"This species differs conspicuously from the young of *G. Vanuxemi* by its closed umbilicus, and the usual absence of undulations or annulations upon the shell surface or upon the casts." Hall, 1897.

This shell occurs rather rarely in the dark shales. The largest individual observed has a maximum breadth of 47 mm.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland.

Collection.—U. S. National Museum.

[E. M. Kindle.]

ARTHROPODA[1]

CLASS CRUSTACEA

Subclass TRILOBITA

Order OPISTHOPARIA

Family PROETIDAE

Genus CYPHASPIS Burmeister

CYPHASPIS cf. STEPHANOPHORA Hall

Plate XLII, Fig. 9

Cyphaspis stephanophora Hall, 1888, Pal. N. Y., vol. vii, p. 142, pl. xxiv, figs. 2-6.

Description.—"Cephalon. Outline transversely semi-elliptical; length to width as 1 to 1.7. Genal angles produced into recurved spines which are longer than the axial length of the cephalon. Border spinose and thickened by doublure. Frontal area narrow, convex and appressed about the glabella, anteriorly depressed by abrupt curvature to the thickened, slightly reflexed anterior margin.

"*Facial Sutures,* normal for the genus, originating on the occipital

[1] Contributed by Charles S. Prosser with the addition of Onondaga species by E. M. Kindle as indicated.

annulation just within the genal angles, passing obliquely forward and inward to the eye-lobe, thence forward and outward to the anterior margin.

"*Glabella* extending three-fourths the length of the cephalon, subpyriform, convex, bounded by a strong sulcus which becomes shallow over the ocular lobes. Basal lobes pyriform; baso-lateral furrows deep; antero-lateral impressions faintly discernible.

"Cheeks elevated about the orbital node and sloping abruptly to the thickened margin. Palpebral lobes elevated; visual surface not observed.

"The *Surface* of the cephalon is ornamented by strong, scattered pustules which become obsolete upon the border and the genal spines. Upon the occipital ring is a single, strong, spiniform tubercle, generally accompanied by a smaller one on either side. The anterior and lateral margins of the cephalon bear two rows of strong spines, one above the other; those of the upper row being the longer and having their bases upon the proximal surface of the marginal rim. The proximal surface of this rim lies vertically upon the margins of the cheeks, and hence the spines which stand perpendicular to its surface, lie in the horizontal plane; as it approaches the frontal margin this rim becomes turned upward and slightly reflexed, so that towards the anterior extremity the spines of the upper row stand at an angle of nearly 45° to the horizontal. The spines of the lower row are shorter, lying in the horizontal plane on the frontal margin, and deflected below the horizontal plane on the genal margins. Of the spines there are about 18 in the upper and 16 in the lower row.

"A single fragment of a thorax associated with a cephalon of this species shows a very wide and gently arched axis, 6 narrow and flattened segments each bearing a number of strong pustules, of which there are two longitudinal rows upon the pleurae, and for each segment of the axis 5 or 6 pustules which do not appear to be arranged in longitudinal rows. This appearance may, however, be due to the imperfection of the specimen.

Length of cephalon, 4 mm.; width at the posterior margin, 7 mm.; length to the extremity of the genal spines, 8 mm." Hall, 1888.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. One and three-quarters south of Berkeley Springs, West Virginia.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Order PROPARIA

Family CALYMMENIDAE

Genus HOMALONOTUS Koenig

HOMALONOTUS DEKAYI (Green)

Plate XLIII, Figs. 1-7

Dipleura dekayi Green, 1832, Mon. Trilobites N. A., p. 79.
Dipleura dekayi Vanuxem, 1842, Geol. N. Y., pt. iii, p. 150, fig. 1.
Homalonotus dekayi Emmons, 1860, Man. Geol., p. 146, figs. 134, 135.
Homalonotus dekayi Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 113.
Homalonotus dekayi Hall and Clarke, 1888, Pal. N. Y., vol. vii, p. 7, pl. ii, figs. 1-11; pl. iii, figs. 1-5; pl. iv, figs. 1-6; pl. v, figs. 1-10.
Homalonotus dekayi Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.
Homalonotus (Dipleura) dekayi Clarke, 1903, N. Y. State Mus., Bull. 65, p. 712.
Homalonotus dekayi Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 318, fig. 1631.

Description.—General from elongate, linguiform, anterior and posterior extremities produced and subangulate; lateral margins nearly straight and approximating posteriorly; length to width about as two to one. Surface depressed-convex or flattened, obscurely trilobate, abruptly deflected along the lateral margins. Cephalon broadly subtriangular in outline, posterior side the longest; angles rounded; glabella subquadrangular, broadest behind; movable cheeks flattened and when normally preserved abruptly deflected; eyes situated at the summit of strong, elevated nodes. Thorax broad, length equal to the width; surface depressed-convex; scarcely trilobate, lateral portions abruptly deflected; axis broad, making two-thirds the width of the body; pleurae narrow, deflected along their median line. Pygidium subtriangular, anterior margin with a forward curve, lateral margins nearly straight, with an upward curve near the posterior extremity, which is produced into a subspatulate extension; surface convex, faintly trilobate; ten annulations on the axis and eight upon the pleurae, which are rarely visible upon the dorsal surface except in young individuals. The surface of the test on its more prominent portions marked by the openings of large vertical tubulipores, the edges

of which project in some specimens and in internal impressions frequently give the surface a pustulose appearance to the naked eye.

The Maryland Collection contains two exfoliated specimens of pygidia of moderate size belonging to this species. Both clearly show casts of the tubulipores and one of them the upward subspatulate extension at its posterior end, the tip of the other being broken. The tubules of the Maryland specimens are apparently closer together and the openings of the tubulipores smaller than in the majority of New York specimens. The outline and other characters of the specimens agree closely with those of this species. Apparently the species is not common in Maryland and these two specimens are preserved in rather coarse arenaceous shales quite similar in lithologic appearance to shales in which they are most frequently found in central New York. Later, a few additional specimens of this species were found at other localities.

Length of largest pygidium, the tip of which is gone, about 30 mm.; width, 42 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. On road east of Pine Hill about 4 miles north of Oldtown; Williams Road, 3½ miles southeast of Cumberland; Williams Road ¼ mile east of Queen City Hotel, Cumberland; on Hancock-Harrisonville Road about 2 miles north of Hancock; west of iron bridge over Town Creek northeast of Oldtown; on east side Warrior Mt. east of Rush.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

Family PHACOPIDAE

Genus PHACOPS Emmrich

PHACOPS RANA (Green)

Plate XLIII, Figs. 8-12

Calymene bufo var. *rana* Green, 1832, Mon. Trilobites N. A., p. 42.
Phacops bufo Emmons, 1860, Man. Geol., p. 138, fig. 124 (6).
Phacops rana Hall, 1861, Descriptions New Species of Fossils, etc., p. 55.
Phacops rana Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 93.

Phacops rana Meek and Worthen, 1868, Geol. Surv. Ill., vol. iii, p. 447, pl. xi, figs. 1*a*-*e*.

Phacops rana Nicholson, 1873, Pal. Prov. Ontario, p. 123, fig. 56*a*.

Phacops rana Whitfield, 1882, Geol. Wis., vol. iv, p. 339, pl. 26, figs. 17-19.

Phacops rana Hall and Clarke, 1888, Pal. N. Y., vol. vii, p. 19, pl. vii, figs. 1-11; pl. viii, figs. 1-18; pl. viii A, figs. 21-33.

Phacops rana Keyes, 1891, Johns Hopkins Univ. Circ., vol. xi, p. 29.

Phacops rana Clarke, 1903, N. Y. State Mus., Bull. 65, p. 737.

Phacops rana Clark and Mathews, 1906, Md. Geol. Surv., vol. vi, pl. xvii, fig. 9.

Phacops rana Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 323, fig. 1638.

Description.—General form elongate suboval; greatest width (measured at the posterior margin of the cephalon) to axial length as 1 to 2; the cephalon, thorax and pygidium are to one another in length as 1.5 to 2 to 1. Cephalon subsemicircular, the regularity of the outline interrupted by the slight protrusion of the glabella and the genal extremities, frontal margin obscure, concealed by the overhanging glabella; facial sutures rarely discernible; glabella large, gibbous, outline subpentagonal, greatest width anteriorly, posterior furrow extending clear across the glabella; cheeks abruptly sloping to the margin, narrowing anteriorly and reflected ventrally to form the doublure; eyes prominent, scarce reaching the height of the glabella in uncompressed specimens, visual area lunate, separated from the cheek by a strong, smooth sulcus, average number of lenses in normal adults is between forty and fifty for each eye. Thorax subquadrate, lateral margins slowly tapering, surface strongly trilobate; axis flattened at the margins, evenly convex in the middle, widest at the third or fourth segment, tapering very slowly to the ninth, and thence much more rapidly to the pygidium; pleurae flat for about one-third their width from the axis and thence abruptly deflected to the margin, each segment bears a furrow which becomes obsolete at the fulcrum. Pygidium relatively small, regularly and evenly rounded margin the posterior part of which forms the arc of a circle; axis composed of nine annulations, rapidly and evenly tapering from the last segment of the thorax, reaching an acute termination just within the posterior margin; pleurae seven in number, broad, depressed-convex, and sloping evenly to the posterior margin. Surface of the test ornamented with tubercles, which are largest and most closely set upon the glabella.

This widely distributed and abundant species is represented in Maryland mainly by broken specimens, the cephalon and pygidium being the parts which are most frequently found. These were compared with authentic specimens of this species in the office of the State Paleontologist of New York, and found to agree closely in all essential characters. The species is found more commonly in Maryland in the argillaceous shales of the Hamilton, but also occasionally in the arenaceous shales. The species was reported by Hall and Clarke from the Hamilton shales at Cumberland, Md. (Pal. N. Y., vol. vii, p. 26).

Length of nearly perfect cephalon, 15 mm.; width, 25 mm. Length of most nearly perfect pygidium, 9 mm.; width, 15 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; on National Road 1/2 mile west of Tonoloway Ridge; Licking Creek east of Warren Point; McCoys Ferry; southwest of McCoys Ferry; Ernstville; on road east of Pine Hill about 4 miles north of Oldtown.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

PHACOPS CRISTATA Hall

Plate XLIII, Figs. 13-15

Phacops cristata **Hall, 1861, Desc. New Sp. Fos., p. 67.**
Phacops cristata **Hall and Clarke, 1888, Nat. Hist. New York Paleontology, vol. vii, p. 14, pl. vi, figs. 1-31; 16-29; pl. viiiA, figs. 1-4.**
Phacops cristata **Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 107, pl. x, figs. 6-8.**

Description.—This species is distinguished by the following features according to Hall. The annulations of the pygidium are dichotomous; termination of axis is obtuse, the axial row of spines extend as far as the pygidium, the glabella is strongly protuberant, tuberculations are numerous only on the glabella, the genal angles bear stout spines, there are 10 to 11 crenulations on each side of submarginal furrow of cephalon, corneal lenses number 23 to 45.

This species and the related form *P. cristata* var. *pipa* are probably the most abundant representatives of the trilobites in this Onondaga

fauna. Although *P. cristata* is readily distinguished from *P. pipa* by the axial row of spines and other less conspicuous differences in perfect specimens, the two are often difficult to discriminate in the fragmentary material representing them in the average collection. The glabella figured represents the largest individual observed, its length and breadth are respectively 18 and 24 mm. The genal spines, though not shown in the figure, are indicated by broken bases in the specimen.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Twenty-first Bridge; Williams Road, 3½ miles southeast of Cumberland; Tonoloway; Hanging Rock, West Virginia.

Collections.—Maryland Geological Survey; U. S. National Museum.

[E. M. Kindle.]

PHACOPS CRISTATA var. PIPA Hall

Plate XLIII, Figs. 16, 17

***Phacops cristata* var. *pipa* Hall, 1888, Pal. N. Y., vol. vii, p. 18, pl. viiiA, figs. 5-18.**

***Phacops cristata* var. *pipa* Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 108, pl. x, figs. 9, 10.**

Description.—" The essential points of difference between this form and the normal *Phacops cristata,* are the following: (a) greatly inferior size, (b) absence of the axial row of spines, (c) smaller spines at the genal angles, (d) fewer annulations upon the pygidium, (e) smaller number of corneal lenses, varying, as ascertained from measurements of a large number of specimens, from 23 to 45 for each eye." Hall, 1888.

The variety seems to be abundant and is very generally present in the calcareous shales and argillaceous limestones of the adjacent states of Pennsylvania and West Virginia. It has been observed at but one locality in Maryland.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. One mile east of Oldtown in cut of Western Maryland Railroad.

Collection.—U. S. National Museum.

[E. M. Kindle.]

Genus DALMANITES Barrande

DALMANITES (CRYPHAEUS) BOOTHI (Green)

Plate XLIV, Figs. 1-4

Cryphaeus boothii Green, 1837, Am. Jour. Sci., vol. xxxii, p. 343 and figure.
Dalmania boothii Hall, 1861, Descriptions New Species of Fossils, etc., p. 63.
Dalmania boothii Hall, 1862, Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 91.
Dalmanites boothii Hall, 1876, Illustrations of Devonian Fossils, pl. xvi, figs. 1-6, 9-11, 13, 15, 16.
Dalmanites (*Cryphaeus*) *boothi* Hall and Clarke, 1888, p. 42, pl. xvi, figs. 1-4; pl. xvi A, figs. 3-8.
Dalmanites boothi Keyes, 1891, Johns Hopkins Univ. Circ., vol xi, p. 29.
Dalmanites (*Cryphaeus*) *boothi* Clarke, 1903, N. Y. State Mus., Bull. 65, p. 683.
Cryphaeus boothi Grabau and Shimer, 1910, N. Am. Index Fossils, vol. ii, p. 329, figs. 1647a, b.

Description.—General form suboval, laterally and posteriorly fimbriate; length about one-half greater than the width; surface depressed-convex, distinctly trilobate; axis prominent, elevated. Cephalon relatively large; outline semielliptical, faintly produced on the frontal margin; length to width as 1 to 2; margin thickened by a broad doublure which is produced at the genal angles into broad, thin and blunt spines that normally reach to the sixth thoracic segment; glabella elongate subpentagonal, length and width equal and nearly equal to length of the cephalon; three pairs of transverse furrows conspicuous; eyes large, elevated, exceeding the height of the glabella; visual surface lunate with 206 lenses for each eye. Thorax length to width as 1 to 1.5; axis arched, widest at the fourth segment, tapering thence evenly to the pygidium; pleurae flattened, gently deflected along the fulcrum. Pygidium subtriangular, depressed convex; axis tapering with slightly incurved margins, and ending abruptly just within the posterior border, with from ten to fourteen annulations; the pleurae each bear five sulcate annulations, the anterior limbs of which are flattened, thickened and produced beyond the margin as short, flat and closely set spines; a similar spine, but shorter and relatively broader, is produced in the axial line, thus making eleven spines in the pygidial fimbria. In the normal forms the entire surface is covered with granulations which become quite strong on the axial region of the glabella and

thorax, and the surface of the pygidial fimbria, where the granules become elongate and pustuliform, often crowded and more conspicuous than upon the surface of the shield itself.

The representatives of this species in the Maryland Collection consist almost entirely of specimens of pygidia which have been found more abundantly in the thin argillaceous shales on the east bank of Evitts Creek just below Wolfe Mill than at any other locality. One badly crushed specimen shows the larger portion of the thorax and the posterior part of the cephalon, while another shows the pygidium and one side of the thorax. The pygidial fimbria in all the specimens are broad, flat, granulose and contiguous as in those of this species and not lanceolate and relatively narrow as in *D. boothi*, var. *calliteles* Green. They were also compared with authentic specimens of *D. boothi* in the office of the New York State Paleontologist and found to be practically identical. It is to be remembered that the original specimens of *D. boothi* were obtained from near Huntingdon, Huntingdon County, Pennsylvania (Am. Jour. Sci., vol. xxxii, 1837, p. 345).

Length of pygidium, 10 mm.; width, 17 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. East bank Evitts Creek below Wolfe Mill; on road about half way between Romney and Hanging Rock, W. Va.

Collections.—Maryland Geological Survey; New York State Museum; American Museum of Natural History.

DALMANITES MARYLANDICUS n. sp.

Plate XLIV, Fig. 5

Description.—A single pygidium was found in the lower Hamilton shales at Ernstville, Md., which is considered distinct from other species of this genus, and shows the following characters: Pygidium subovate triangular in outline, conspicuously trilobed and composed of 23 or 24 annulations; axis moderately convex, tapering gradually and extending as far as the posterior margin, marked by two rows of tubercles of which each segment bears two, one on each side of the middle and most convex

part of the axis; pleurae composed of 18 annulations, nearly flat near the axis, thence regularly depressed toward the margin, about the middle of each segment is a furrow which begins near the axis and extends nearly to the margin, while the convex portions of the segments are marked by two somewhat irregularly arranged rows of tubercles, one on each side of the furrow; margin scarcely shown except at the posterior extremity where it is apparently terminated by two caudal spines, which are broad at their bases, separated by a rather greater distance than the width of the axis, and one showing apparently the bases of three or four small spines near its extremity.

This pygidium is to be compared with those of *Dalmanites* (*Coronura*) *aspectans* (Con.) of the Onondaga limestone of New York, Ohio and the Falls of the Ohio; but is considerably smaller than average specimens of that species, while the axis is composed of a larger number of segments and is marked by two longitudinal rows of tubercles instead of five.

Length of pygidium, 13 mm.; width, 22 mm.

Occurrence.—ROMNEY FORMATION, HAMILTON MEMBER. Ernstville

Collection.—Maryland Geological Survey.

Subclass EUCRUSTACEA

Order OSTRACODA

Family LEPERDITIIDAE

Genus LEPERDITIA Ronault

LEPERDITIA ? SUBROTUNDA Ulrich

Plate XLIV, Fig. 6

Leperditia ? subrotunda Ulrich, 1891, Jour. Cin. Soc. Nat. Hist., vol. xiii, p. 181, pl. xvi, figs. 1a, b, c.

Leperditia ? cf. subrotunda Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 115, pl. ix, fig. 7.

Description.—" Size of left valve: Length, 0.68 mm.; thickness, 0.21 mm. Carapace small, short, rounded, uniformly convex, encircled, except at the strongly convex ventral edge, by a flattened border, widest in the

posterodorsal region. Dorsal edge scarcely straight, gently curving into the ends. Ventral overlap distinct. Surface smooth and even, without eye tubercle or muscle spot. The development of a flange at the dorsal border is a very unusual feature in this genus. *L. sinuata* Hall has nearly the same shape, but is without a flange, and so far as known its valves do not overlap at the ventral margin. I am inclined to believe that species of this character ought to be arranged with *Aparchites* rather than *Leperditia*. Position and locality: Devonian Bryozoa bed, Falls of the Ohio. Rare." Ulrich, 1891.

A circular or subcircular ostracode occurs sparingly as casts of the shell at three or four localities represented by the collections. These agree with Ulrich's figures of *L. subrotunda*, except that the projecting flattened border feature appears to be developed but slightly or not at all; the form here compared with *L. subrotunda* may represent a closely related species.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. One and three-quarter miles south of Berkeley Springs, West Virginia.

Collection.—U. S. National Museum.

Family BEYRICHIIDAE

Genus BOLLIA Jones and Holl

BOLLIA UNGULA Jones

Plate XLIV, Figs. 7, 8

Bollia ungula Jones, 1889, American Geologist, vol. iv, pp. 338-339, pl. opp. p. 242, figs. 10-13.

Bollia ungula Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 113, pl. ix, figs. 9, 10.

Description.—" Prof. Claypole's specimens are well preserved casts in buff-colored, non-calcareous shales from the Marcellus limestone of Perry County, Pennsylvania (near New Bloomfield). There are several, and they vary from 1 to $2\frac{1}{2}$ mm. in length. The proportions of some of the best are given in the figures 10-13, magnified 15 diameters. In some

respects they resemble *Bollia lata* Hall;[1] but they are larger, and the central curved ridge is much thinner at its curve, whereas in the specimens from New York State the curve is thicker just there, and is not so symmetrical throughout as in the Pennsylvania specimens. Hence I prefer to regard the latter as specifically distinct, and to adopt Prof. Claypole's MS. specific name (having reference to the hoof-like ridge), than to refer them to *Bollia lata*. A hollow cast of the outside, and one presumably perfect valve give evidence of a smooth exterior.

The slight variations in the shale and proportions of the curved subcentral ridge and of the marginal ridge are well shown in the figures 10-13." Jones, 1889.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southeast of Cumberland; Tonoloway.

Collection.—U. S. National Museum.

BOLLIA OBESA Ulrich

Plate XLIV, Fig. 9

Bollia obesa **Ulrich, 1891, Jour. Cincinnati Soc. Nat. Hist., vol. xiii, p. 189, pl. xiv, figs. 5a, b, c.**

Bollia obesa **Kindle, 1912, Bull. U. S. Geol. Surv., No. 508, p. 114, pl. ix, fig. 8.**

Description.—"Size of valve: Length, 1.52 mm.; height, 0.98 mm.; thickness, 0.5 mm. Carapace subpentagonal, ends nearly equal, strongly curved, back straight, short, dorsal angles obtuse, ventral edge produced in the middle. Marginal portion of valves thick, causing them to appear unusually ventricose. Horse-shoe ridge unsymmetrical, with bulbous extremities, the anterior knob oval, and reaching the dorsal edge, the posterior one larger, more nearly round, and terminating a short distance within the dorsal margin.

"This species is not likely to be mistaken for any other known to me. Though clearly a true *Bollia,* it is very different in its general appearance from the associated *B. ungula,* Jones.

[1] Paleontology of New York, vol. ii, 1852, p. 301, pl. 66a, figs. 10a, b, d (not c and e), also some in British museum. I may here mention that I have to refer *lata* and *symmetrica* to *Bollia*, and *spinosa* to *Aechima*.

"Position and locality: Devonian Bryozoa bed, Falls of Ohio." Ulrich, 1891.

This species is associated with *B. ungula* but is less abundant.

Occurrence.—ROMNEY FORMATION, ONONDAGA MEMBER. Williams Road, 3½ miles southwest of Cumberland; Tonoloway.

Collection.—U. S. National Museum.

THE UPPER DEVONIAN DEPOSITS OF MARYLAND

BY

CHARLES S. PROSSER

AND

CHARLES K. SWARTZ

THE UPPER DEVONIAN DEPOSITS OF MARYLAND

BY

CHARLES S. PROSSER AND CHARLES K. SWARTZ

INTRODUCTORY[1]

As stated under the description of the Middle Devonian, the Devonian period was often separated in a general way into the lower, middle, and upper divisions. For the latter Prof. H. S. Williams proposed the name Neodevonian[2] which in general included, in New York, the Tully limestone, Genesee shale, Portage, Chemung, and Catskill stages, the latter being a local facies of the Chemung, or Portage, Chemung and perhaps early Carboniferous, occurring in southern and southeastern New York.

In 1840, Prof. James Hall named and described the following "groups" as succeeding the "upper Black shale" (Genesee shale) in the Genesee Valley, in the order named: Cashaqua shale, Gardeau or Lower Fucoidal group, and Portage or Upper Fucoidal group.[3] He also stated that "the two groups just described [Gardeau and Portage], occupy a thickness of more than 1000 feet, and are interposed between the Cashaqua shale and the Chemung group."[4] In succeeding accounts, the base of the Chemung formation has generally been considered as resting on top of the sandstones which Professor Hall described as composing the Portage group; but the following statement is important, especially when the classification of the rocks of this part of the Genesee Valley by Dr. J. M. Clarke, is considered. Professor Hall said, "Indeed, if we consider the Chemung group as commencing with the occurrence of its characteristic marine fossils, then several hundred feet more of rocks may be noticed

[1] Contributed by Charles S. Prosser.

[2] Jour. Geol., Vol. II, pp. 155, 157.

[3] 4th Ann. Rep., Fourth Geol. Dist. [N. Y.] (Assembly Doc. No. 50, 1840), pp. 390, 391.

[4] *Ibid.*, p. 392.

as intervening between the upper Portage rock and that group."[1] The following year Professor Hall reported on the geology of Erie County and described the terrains just mentioned under the headings of Cashaqua shale, Gardeau group and Portage group.[2] In Vanuxem's Final Report of the Third District the Cashaqua shale, Gardeau and Portage groups, and Sherburne flagstone and shale of the Annual Reports were combined to form the Portage or Nunda group.[3] Hall's Final Report of the Fourth District, published the following year, contained the same classification.[4] The term Nunda, from the former name of the township which had been changed to Portage, where the rocks of the "group" are finely shown on the banks of the Genesee River, was soon abandoned although its retention would have avoided confusion since Professor Hall first applied the name Portage to the mass of sandstones in the upper part of the "group." The rocks deposited during Portage time in the central and eastern parts of New York have local facies and have received special names.

In the first place in the meridian of Canandaigua Lake Dr. J. M. Clarke found, on studying the faunas of the Cashaqua shales and Gardeau shales and flags, that they were closely related to that of the Genesee shale and he proposed the name Naples beds or shales for these two lower divisions of the Portage.[5] In another paper published the same year Dr. Clarke stated that in Ontario County the Cashaqua shales and the Gardeau shales and sandstones are both lithologically and palæontologically a single group to which has been applied the name Naples shales.[6] Finally, in 1891, it was stated by Dr. Clarke that he used the term Naples beds for the subdivisions of the Portage which had been called the Cashaqua and Gardeau and to their faunal contents he applied the name Naples fauna.[7] In 1898, Dr. Clarke called attention to the fact that in the section west of Ontario County the heavy bedded Portage

[1] *Ibid.*, p. 392.
[2] 5th An. Rep., *ibid.* (Assembly Doc. No. 150, 1841), pp. 165, 166.
[3] Geol. N. Y., Pt. III, 1842, p. 172.
[4] *Ibid.*, Pt. IV, p. 224.
[5] Bull. U. S. Geol. Surv., No. 16, 1885, p. 36, f. n.
[6] 4th Rep. State Geologist [N. Y.], p. 20, f. n.
[7] Amer. Geol., Vol. 8, p. 93.

sandstones "are overlaid by a considerable mass of flags and sands which continue to carry a Naples fauna with some modifications, but embrace no typical Chemung species."[1] This upper zone carrying a Naples fauna and overlying the Portage sandstone is the one noted in 1840 by Professor Hall in the Genesee Valley to which in a section of this valley Dr. Clarke gave the name "Wiscoy shales and flags."[2] In the succeeding report appeared an extended account of "The Naples fauna (fauna with *Manticoceras intumescens*) in western New York" in which Dr. Clarke gave a history of the Portage group and this fauna.[3]

Later and more detailed stratigraphic work by Dr. J. M. Clarke and Mr. D. Dana Luther in western New York has resulted in a greater subdivision of the Upper Devonian rocks. A recent publication devoted to this subject is their "Geologic map of the Canandaigua and Naples quadrangles" on which the several formations of these two quadrangles are very accurately represented. The rock formations represented as units of sedimentation "are given in the right-hand column of the following table, divisions of broader value constituting the other three columns:

Neodevonic	Chautauquan group	Chemung beds	Prattsburg. Highpoint.
	Senecan group	Ithaca beds	West hill. Grimes.
		Portage beds	Hatch. Rhinestreet. Cashaqua, Parrish (lentil in Cashaqua). Middlesex.
		Genesee beds	Standish. West river. Genundewa. Genesee.
		Tully limestone	Tully."[4]

[1] 15th An. Rep. State Geologist [N. Y.], p. 58.

[2] *Ibid.*, p. 62.

[3] 16th An. Rep. State Geologist [N. Y.], 1899 [April, 1900], p. 41. Reprint issued in 1898.

[4] N. Y. State Museum, Geologic map of the Canandaigua and Naples quadrangles, April, 1904, p. 2. For descriptions of the above formations, see pp. 18-32.

The rock formations composing the Portage beds in the above table were also described by Dr. Clarke in another memoir published earlier in April than the one just quoted in which he stated that "Throughout this interval of about 600 feet the Naples fauna prevails, without evidence of encroachment of the eastern or Ithaca fauna." [1]

The following year in the description of the geology of the Watkins and Elmira quadrangles Dr. Clarke transferred the High Point sandstone from the Chautauquan to the Senecan, while the Chautauquan began with the Prattsburg shale succeeding which is the Chemung sandstone and shale.[2] *Spirifer disjunctus* Sowerby occurs in the list of fossils from the Chemung sandstones;[3] Hall's original description of the "Chemung group" is quoted, following which Dr. Clarke stated that "It will be seen that the definition of this formation is derived from the very region we have here under consideration and embraces those rocks to which we are now applying the term in the original and restricted meaning."[4] The above classification has recently been reviewed by Prof. H. S. Williams who wrote that "According to the list of species reported by them [Clarke and Luther] for the Watkins and Elmira quadrangles their West Hill flags and shales and High Point sandstone should both be included in the Chemung formation as here defined [in the Watkins-Catatonk folio]."[5]

The above rather extended review of the use of the names Portage and Naples in their typical sections in western New York is given in order that the reader interested in stratigraphical geology may readily acquaint himself with the historical usage of the names which appear very frequently in this monograph in the description of the Upper Devonian rocks and fossils of Maryland.

Again, east of the Naples section in the Ithaca region the Portage stage is represented by the Sherburne sandstone and Ithaca beds and the writer in 1903 proposed that these two members be united and

[1] N. Y. State Museum, Mem. 6, p. 213.
[2] N. Y. State Mus., Bull. 81, p. 4.
[3] *Loc. cit.*, p. 24.
[4] *Loc. cit.*, p. 23.
[5] Geol. Atlas U. S., Folio 169, Field Edition, 1909, p. 85.

called the Unadilla formation,[1] while farther east along the Chenango Valley it is represented by the Sherburne sandstone, Ithaca beds and Oneonta sandstone. When followed eastward, sediments with the lithological characters of the Oneonta appear at lower and lower horizons in the Ithaca until the Ithaca fauna disappears. In a similar manner the Chemung fauna above the Oneonta sandstone is driven out until in the Catskill region of southeastern New York the Hamilton formation and fauna are succeeded by the Sherburne sandstone, which is followed by sediments not lithologically different from those of the Oneonta which pass without any break into the similar lithological deposits of the Catskill formation.[2]

Dana in his time division of the Devonian placed the upper or later portion in the Chemung and Catskill periods.[3] The Chemung period as defined in his earlier editions of the Manual of Geology was composed of the Portage and Chemung epochs, the Tully and Genesee being included in the Hamilton period, and the Catskill period composed of simply the Catskill epoch. In the last edition, however, the Upper Devonian consists simply of the Chemung period at the base of which was the Genesee shale while the conclusion, that the Catskill is a local formation representing a varying thickness of the Upper Devonian, was accepted and so the name disappeared from the chronological list.[4] Among the names proposed by Mr. Darton for the formations of central Appalachian Virginia and adopted by the United States Geological Survey for the Folios of that region, the Jennings formation, called from Jennings gap and branch in western Augusta County, Virginia, agrees very closely with the Genesee, Portage, and Chemung formations of New York. The line of division between the Romney and Jennings formations was not indicated very distinctly and it was said that they "intergrade through beds of passage." In reference to the correlation of the Jennings formation it was stated that "very few beds are fossiliferous, and they are

[1] Amer. Geol., Vol. XXXII, 1903, p. 384.

[2] For details of this region and the varying lithologic and faunal characters of the formations see Prosser in the 15th An. Rep. State Geol. [N. Y.], 1897 [1898], pp. 87-223 and 17th *ibid.*, 1899 [1900], pp. 64-316.

[3] Proc. Am. Assoc. Adv. Science, Vol. ix, 1856, p. 14.

[4] Man. Geol., 4th ed., 1895, pp. 576, 602.

mainly in the medial beds where Chemung and Portage forms occur comprising *Spirifera disjuncta, Spirifera mesocostalis, Streptorhynchus chemungensis, Chonetes scitula,* and others,"[1] while Hampshire called from the county of that name in northeastern West Virginia corresponds in a general way to the upper portion of the Catskill formation of southeastern New York. Finally, Clarke and Schuchert propose that the Upper Devonian be divided into the Senecan and Chautauquan periods or groups; the Senecan composed of the Tully limestone, Genesee shale, and Portage beds which include the terms Naples beds, Ithaca beds and Oneonta beds as local facies of that stage, and the Chautauquan composed of the Chemung beds of which the Catskill sandstone is given as a local facies.[2]

The Maryland Geological Survey adopted Jennings formation for the name of the division succeeding the Romney for a reason similar to that given in explanation of the Romney formation. The name Chemung was first used as the name of a stage, but Dana considered it as the name of a period composed of the Portage and Chemung epochs, so that it is in common use as the name of a stage or age, using the terms proposed by the International Congress of Geologists, as well as for the name of the higher division of series or epoch. Jennings was already in use by the Maryland Geological Survey before the publication of the names Senecan and Chautauquan by Clarke and Schuchert and, for convenience in mapping, it was also found better to regard it as one formation.

The name Hampshire was used in the earlier publications of the Maryland Geological Survey, instead of Catskill, because of the controversy over the limits of that formation in New York, and because the question had been raised whether, on account of the absence of fossils, it is possible to correlate the upper Devonian red rocks of Maryland and West Virginia with those of New York. Recognizing the fact, however, that the Catskill formation in different parts of New York represents a different length of geological time, it is believed that the southern red deposits have the same general stratigraphic position and may be followed across Pennsylvania to Maryland.

[1] Am. Geol., Vol. x, 1892, p. 18.
[2] Science, N. S., Vol. x, 1899, p. 876.

STRATIGRAPHIC AND PALEONTOLOGIC CHARACTERISTICS[1]

THE JENNINGS FORMATION

INTRODUCTORY

At or near the base of the Jennings formation in Allegany County and apparently confined to it are black, fissile shales, with a thickness of about 90 feet, which weather to a gray color and readily turn to soil. In Washington County the olive shales and thin sandstones of the succeeding division rest on top of the upper Romney sandstones and the black shales have disappeared by thinning out to the eastward. The black shales contain fossils which occur in the Genesee shales of New York as for example: *Buchiola retrostriata* v. Buch, *Pterochaenia fragilis* (Hall), *Styliolina fissurella* Hall, *Bactrites aciculus* (Hall), and other species. Among the best exposures are those to be observed in the cut above Corriganville, by the side of the National Road 2½ miles northeast of Cumberland and on Flintstone Creek in Gilpin.

The black shale occurring at or near the base of the Jennings is believed to represent the same horizon at the several localities at which it has been noted in Allegany County. A characteristic Hamilton fauna is known to extend within at least 30 feet of the black shale, and perhaps to its base since the interval of 30 feet is covered, while similar recurring black shales were not noted in the superjacent beds of Portage age as is the case in the deposits of this stage in western New York. On account of its stratigraphic position it is thought that this black shale represents the reappearance of conditions in Maryland similar to those which existed in central and western New York while the Genesee shale was being deposited, but which were absent during that time in eastern New York and eastern Pennsylvania, and it has been provisionally correlated with the Genesee shale of New York. The time of its deposition may not have been precisely identical with that of the Genesee shale of New York; however, it is believed that the difference in time was not great.

The next member of the Jennings formation consists mainly of greenish argillaceous and arenaceous shales alternating with thin sandstones of similar color all of which weather to a yellowish-green. The sandstones which usually vary in thickness from a fraction of an inch to a foot,

[1] Contributed by Charles S. Prosser.

though there are occasional strata 2 feet in thickness, occur throughout this part of the formation; but as a rule are not thick enough to be of any economic importance. In Washington County brownish-red shales occur in the upper part of this division; but in Allegany County reddish rocks make their first appearance in the succeeding member. Fossils are not common near its base although specimens of *Buchiola retrostriata* v. Buch, *Pterochaenia fragilis* (Hall), *Tornoceras uniagulare* (Conrad), *Bactrites aciculus* (Hall) and some other species occur. A profuse fauna has been observed in the higher strata of this member by Dr. Swartz who correlates them with the Ithaca beds of New York. Its thickness is estimated at 1200 to 1600 feet. This division of the Jennings formation has been named the Woodmont member by Swartz and is regarded as representing the Sherburne and Ithaca stages of New York. It is fairly well shown on the bank of Town Creek and the lower slope of Polish Mountain on both the National and Williams Roads and in the upper part of the section near Woodmont west of Tonoloway Station.

The succeeding division, named the Parkhead member by Swartz and Stose, consists of shale and interbedded sandstones and conglomerates. It was shown to contain an abundant fauna of Hamilton affinities by Dr. Swartz who discusses it more fully elsewhere in this volume. Its thickness is 400 to 600 feet.

The upper part of the Jennings formation consists of argillaceous and arenaceous shales alternating with beds of sandstone which are very often micaceous, while several layers of conglomerate occur in this member. These shales and sandstones are usually greenish or greenish-gray in color and weather to a yellowish-green; but there are not infrequent zones of brownish-red shales and sandstones. In certain layers fossils are common and the characteristic species *Spirifer disjunctus* Sowerby of the Chemung stage occurs frequently and this together with the presence of other Chemung species, lithologic similarity and stratigraphic position indicates the correctness of the correlation of this division with the Chemung stage of New York.

The writer correlated the beds between the top of the Genesee shale, or where this shale is absent the top of the Romney, and the lowest ones containing *Spirifer disjunctus* Sowerby with the Portage of New York. The

succeeding part of the Jennings formation he correlated with the Chemung of New York.

In the Jennings Run section there is a 40 foot zone of sandstone and conglomerate shown in the highway cut about 550 feet below the top of the formation. In Garrett County the conglomerates are quite conspicuously represented by loose blocks; but are not often found in place. One, containing quite large flat white quartz pebbles, is found frequently to the northeast of Oakland and in the vicinity of Mountain Lake Park.

This conglomerate is light gray in color, slightly fossiliferous, contains numerous milky quartz pebbles, part of which at least are flat and lenticular in shape, but none of jasper were seen by the writer, while the jointing surfaces of the blocks cut directly across the pebbles making a smooth surface. Apparently the rock always breaks straight across the pebbles in a direction at right angles to their bedding, and the cementing material is dark, gritty, and somewhat ferruginous. Regarding the presence of jasper pebbles Dr. Martin has written as follows: "I have not noticed jasper pebbles in the Chemung near Corriganville [Jennings Run section]. I have seen a few in the vicinity of Mountain Lake Park and Oakland and also to the south of Oakland. I do not remember seeing them elsewhere."[1] It is clearly shown at several localities to the northeast of Oakland that this conglomerate is succeeded by a considerable thickness of rocks containing abundant specimens of *Spirifer disjunctus* Sowerby, *Atrypa hystrix* Hall, *Douvillina cayuta* Hall, and other Chemung species so that there can be no doubt that the stratigraphical position of this conglomerate is considerably below the top of the Chemung. In this region a higher conglomerate occurs about 50 feet below the base of heavy reds which are considered as forming the base of the Catskill formation.[2] This stratum, 6 inches more or less in thickness, occurs in the midst of yellowish-green shales and contains numerous quartz pebbles which are not so lenticular in shape as those in the lower conglomerate. On Pea Ridge, southeast of Avilton, in the northern part of the county a similar conglomerate occurs, containing small, mostly rounded quartz pebbles which do not break with a smooth fracture on the joint planes but

[1] Letter of January 12, 1904.
[2] See an alternative interpretation by C. K. Swartz in this volume.

either project from or drop out of the matrix so that its appearance is quite different from that of the lower, conspicuous conglomerate.

In Bedford and Fulton counties in Pennsylvania to the north of Allegany County, Maryland, Professor Stevenson described two conglomerate layers in the Chemung separated by 950 feet of shales and sandstones which he designated from their stratigraphic positions the lower and upper conglomerates."[1] The upper part of the Chemung is imperfectly shown in both Bedford and Fulton counties; but Professor Stevenson in his "generalized section" for the latter county has given 800 feet of "shales with occasional beds of sandstone" as overlying the upper conglomerate before the top of the Chemung is reached.[2] From their stratigraphic position it is evident that the two conglomerates just described in Maryland do not represent the lower and upper conglomerates in Pennsylvania both of which contain flat pebbles as described by Professor Stevenson. The upper one of Professor Stevenson, however, occurs near the stratigraphic position of the lower one just described in Maryland and there is some probability that these two are identical. This opinion is somewhat strengthened by Professor Stevenson's statement that in Bedford County the beds overlying the upper conglomerate are quite fossiliferous containing *Spirifer disjunctus* Sowerby, *Streptorhynchus chemungense* (Conrad), *Orthis* closely allied to *O. tioga* Hall, and "great numbers of characteristic Chemung Lamellibranchs."[3] Dr. I. C. White correlated the upper conglomerate of Stevenson with his Lackawaxen conglomerate found on the bluff of the Delaware River near the town of that name in northeastern Pennsylvania.[4] Although later, in describing the formations west of Cumberland, he stated that "*The Chemung beds* consist of olive shales, flaggy sandstones, and one massive conglomerate (Allegrippus) [the name which he gave to Stevenson's lower conglomerate[5]] near the top; thickness about 2500 feet."[6] Dr. Martin also wrote that the flat pebble conglomerate of Garrett County

[1] 2d Geol. Surv. Pa., T^2, 1882, p. 76.

[2] *Ibid.*, p. 75.

[3] *Ibid.*, p. 78.

[4] *Ibid.*, T^3, 1885, p. 90, f. n. p. 91, and section on p. 96.

[5] *Ibid.*, pp. 99, 101, 103.

[6] Congrès Géolg. Internat., Compte Rendu de la 5me Ses., Washington, 1901 (1903), p. 282.

"suggests very strongly the Lackawaxen conglomerate of Pennsylvania";[1] while Professor Claypole stated that "the two conglomerates, the Allegrippus and the Lackawaxen, ... figure conspicuously in the outcrops of the Chemung from Virginia to New York."[2] Professor Lesley, however, called attention to the fact that the Reports for Blair, Center, Clinton, Lycoming, Union, Snyder, Mifflin, and Juniata counties situated in the line of strike of these formations to the northeast of Bedford, Fulton, and Huntingdon counties make no mention of these conglomerates.[3] He also considered the one described by Dr. I. C. White at Roaring Run, Columbia County, intermediate in location between those of the southern counties and the Lackawaxen conglomerate of Pike County, which Dr. White provisionally correlated with the latter conglomerate,[4] and concluded that "Considering the solitary apparition of this Rocky [Roaring] Run conglomerate, as we may call it, and the large number of fish beds known to exist in Chemung and Catskill series, it seems to me a little hazardous to adopt unhesitatingly its identity with other fish-bed conglomerates in distant counties of the state. We must leave to future explorers the task of proving or disproving such facts."[5]

It appears to the writer that there is as yet insufficient evidence to warrant the correlation of Stevenson's upper conglomerate of Bedford, Fulton, and Huntingdon counties with the Lackawaxen conglomerate of northeastern Pennsylvania. This conclusion appears to be warranted when we consider the rather limited extent, in general, of deposits of this character and especially when it is noted that Dr. White stated that many of the pebbles of the Lackawaxen conglomerate are angular and exhibit "little evidence of water wear"[6] while the pebbles of Stevenson's upper conglomerate he described as "generally *flat*."[7]

[1] Md. Geol. Surv. Garrett Co., 1902, p. 87.
[2] Am. Geol., Vol. XXXII, 1903, p. 105.
[3] Geol. Surv. Pa. Sum. Desc. Geol. Pa., Vol. II, 1892, p. 1552.
[4] 2d Geol. Surv. Pa., G^7, 1883, pp. 59, 303.
[5] *Loc. cit.*, p. 1553, footnote.*
[6] G^6, p. 156.
[7] T^3, p. 93. In Professor Stevenson's description he stated that "The larger pebbles are flat" (T^2, p. 76).

In the northern part of Garrett County are numerous loose blocks of white quartz, flat pebble conglomerate, some of which contain jasper pebbles, as shown on the National Road about 5 miles from Frostburg on the Graham farm, on the Frostburg-Salisbury Road near the Baker house, and to the south of the National Road on Pea Ridge near Avilton. The pebbles in these blocks are evenly broken so that there is a smooth fracture similar to that of the flat pebble conglomerate in the Oakland region and the one found in place 1½ miles south of Avilton opposite the house of Mr. John Robinson. The jasper pebbles, however, are infrequent in the more southern localities just mentioned and the writer is not certain that the two conglomerates are identical. Professor Stevenson in the description of his upper conglomerate of Bedford County mentioned rounded and flattened pebbles of white quartz,[1] but apparently none of jasper; while Dr. I. C. White in describing what he considered as the same conglomerate in Huntingdon County distinctly called attention to "its red jasper (?) pebbles."[2] Professor Stevenson also stated that the upper conglomerate in Bedford County had "films of quartz in the joints"[3] which the writer believes is likewise true of the Garrett County conglomerate and Dr. Martin has noted that the joints of the Maryland conglomerate "are frequently coated with drusy quartz."[4] It is not improbable that further study may show that the flat pebble, jasper conglomerate of Garrett County is identical with Stevenson's upper conglomerate of Pennsylvania.

The flat pebble, jasper conglomerate of northern Garrett County is named the Avilton conglomerate on account of its occurrence near the post-office of that name on Pea Ridge. The flat pebble, white quartz conglomerate found farther south on Pea Ridge, frequently in the Oakland-Mountain Lake Park district and to the south of Mountain Lake Park and Oakland probably belongs to the same horizon although the writer was unable to demonstrate it to his satisfaction. These conglomerates apparently occur much below the top of the Jennings formation and their boulders as stated by Dr. Martin "are found along a more or less distinct line of

[1] T^2, p. 79.
[2] T^3, p. 93.
[3] T^2, p. 79.
[4] Md. Geol. Surv., Garrett Co., p. 87.

hills parallel to and about half a mile from the outer and upper contact of the formation." [1]

Succeeding the conglomerate in Jennings Run are 550 feet of rocks that have been put in the Jennings formation in which Chemung fossils occur. These rocks consist largely of coarse grained, micaceous, greenish-gray and brownish-red sandstones alternating with shales. In Garrett County there are zones above the flat pebbled conglomerate in which abundant specimens of Chemung fossils occur, among which the characteristic species *Spirifer disjunctus* Sowerby is common. This part of the formation contains the most fossils and is one of the best collecting grounds for Chemung fossils in Maryland. The soil derived from the Jennings formation is yellowish in color.

The thickness of the Jennings formation of Maryland, varies, according to the measurements of Swartz and Ohern, from 3400 to 4750 feet. It represents the Genesee shale and Portage and Chemung stages of New York and No. VIII, e, f, and g of Pennsylvania.

DISTRIBUTION OF THE JENNINGS FORMATION

The most eastern Jennings rocks in Maryland are found just west of the eastern belt of the Licking Creek area of the Romney formation and extend westward for 4 miles to Pigskin Ridge. Near the middle of this area on the Potomac River is Millstone which furnishes an appropriate name for this area of the Jennings. To the west of Timber Ridge, including the valley of the Great Tonoloway Creek, and extending nearly to Hancock is a belt of the Jennings formation about 1¼ miles in breadth.

In the western part of Washington County to the west of the Tonoloway area of the Romney formation a belt of the Jennings formation varying from three-fourths to nearly 1 mile in breadth crosses the state in a parallel direction to that of the Romney area just mentioned. West of Sideling Hill is another belt of the Jennings formation, about 1¼ miles wide on the Maryland-Pennsylvania state line, in which part of the valley of Sideling Hill Creek has been excavated, and the greater part of this area lies to the west of this creek in the eastern part of Allegany

[1] Md. Geol. Surv., Garrett Co., p. 87.

County. This may be called the Sideling Hill Creek area of the Jennings formation.

In Allegany County the Jennings occupies the center of the Pawpaw anticline and outcrops in a wide area extending from the east slope of Green Ridge to the west side of Polish Mountain. It also forms a broad belt east of and parallel to the Alleghany Front.

In Garrett County it occupies the center of the Oakland anticline and is exposed in a small area west of Accident.

Exposures in Washington County

Exposure East of Millstone.—Under the description of the Middle Devonian, exposures of the Upper Romney have been described on the National Road to the southeast of Millstone and about one-half mile west of Licking Creek. That part of the section closes with massive grayish sandstone, alternating with shales and is regarded as near the top of the Romney. The exposures are somewhat infrequent, accompanied by rolls and changes in the dip so that no attempt was made to measure the thickness of the rocks in this section.

No. 1. Succeeding the Romney to the westward is the Jennings formation, the first exposures of which are not far beyond the last one described under the Romney. These rocks consist of rather mealy, micaceous, arenaceous to argillaceous shales, some of which are thin and buff. No fossils were found. Some of the harder blocks resemble in lithologic appearance the Woodmont member of the Jennings formation to which it is believed they belong.

No. 2. On the William E. Jones farm about 2 miles east of Millstone from the excavation for a well were obtained brownish-red sandstones with olive shales and thin sandstone. Some of the sandstones contain fossils, as *Camarotoechia* and segments of large Crinoid stems. The sandstones are quite reddish and these rocks apparently belong in the lower part of the Chemung stage of the Jennings formation.

No. 3. In a small quarry, which is no longer worked, one-half mile east of Millstone are red micaceous and gray sandstones alternating with olive and red argillaceous shales. There is also an occasional stratum

of cornstone or a calcareous layer containing pebbles. In one of these strata in the lower part of the quarry are a few poorly preserved fossils. The dip is 20° S., 15° E. This quarry was opened for flagstones without success but it would yield dimension stone for foundations and similar purposes. To the west of the quarry along the hillside the rocks are mainly red argillaceous shales, but there are some greenish shales and sandstones alternating with the red rocks.

No. 4. Outcrops in the cliff to the west of the house of George Pelton composed largely of red argillaceous pencil shale with thin sandstone layers in the upper part. In this part of the zone is a slightly calcareous layer in which *Spirifer mesastrialis* Hall is abundant and there are a few other species the most abundant one of which is *Ambocoelia umbonata* (Conrad). Farther toward the west the sandstones are more prominent, one massive stratum, near which a few fossils were found, being over 6 feet thick. There are also numerous pieces of coarse grit varying to conglomerate. The upper part of this zone is very red. In the red rocks to the east of the house no fossils were found. The thickness of this zone is estimated as about 500 feet.

No. 5. A little farther west and with continuous exposures from No. 4 is an excavation where shale is obtained for the highway. At the top of No. 4 is a zone of yellowish shale, some of it partly mottled, in which there are fossils, as for example *Ambocoelia umbonata* (Conrad), *Chonetes,* and several species of pelecypods. These shales are mostly soft and argillaceous and below them are brownish to somewhat reddish ones as well as buff and some that are decidedly olive in tint. In the shales along the road in ascending the slope to the west, no fossils were found. This zone was estimated as 275 feet in thickness, the lower part of which is composed mostly of buff shales. A little farther west are buff, argillaceous shales, somewhat micaceous but non-fossiliferous. There are also layers of sandstone one of which is massive, of fairly greenish-gray color, very hard and about 7 feet in thickness.

From numbers 4 and 5 of this section east of Millstone the following species as determined by Dr. Clarke were collected: *Ambocoelia umbonata*

(Conrad), *Atrypa hystrix* Hall, *Chonetes* sp., *Chonetes lepidiformis* Clarke, *Cyrtina hamiltonensis* Hall, *Spirifer mesastrialis* Hall.

No. 6. By the side of the road in Millstone are thin, olive, micaceous shales alternating with thin bedded, olive sandstones all of which are in the Woodmont member of the Jennings formation. No fossils were found in these rocks. The dip is about 40° S., 10° E.

No. 7. In the western part of Millstone is a blocky sandstone, near the axis of the anticlinal fold, which belongs in the Hamilton stage of the Romney formation. The rocks of zone No. 7 were described under the section of the Romney at Millstone.

No. 8. By the side of the road to the west of Millstone and just east of the first creek west of that village, are olive, thin bedded shales alternating with thin sandstones. In the excavation immediately east of the creek is a band of brownish-red shale similar to that described in the Upper Chemung in the outcrops east of Millstone. One of the layers contains a large and long Crinoid stem and this was the only fossil found at this locality. The red shale is about 6 feet in thickness and some of the olive shales are fairly thick and quite arenaceous. From this locality to the vicinity of Hancock, the rocks are not well exposed but they belong in the Jennings formation with the exception of the Catskill belt from Pigskin Ridge to the western slope of Timber Ridge. The important thing to note in the lithological characters of this section is the early appearance of bands of red shale as compared with the section to be described in Allegany County. In the more western sections the red rocks made their first appearance well up in the Chemung and above a fauna composed of a number of characteristic species of that stage; while east of Hancock they occur below the Chemung. This earlier appearance of the conditions toward the east favorable for the deposition of the red rocks agrees with their occurrence in southern New York, where in the eastern part they begin as a continuous mass of red and green rocks fully as early in time as in this section, while along the southern border half-way across the state they are not seen until near the close of the Chemung stage.

Exposure between Tonoloway Ridge and Sideling Hill.—There is a ledge of quite massive greenish-gray sandstone on the National Road about

4 miles west of Hancock which is supposed to mark the top of the Romney formation.

No. 1. Then after passing a covered interval of a few feet, olive shales of the Woodmont member of the Jennings, with an occasional sandstone 2 or 3 inches in thickness, begin. These shales stand at a very high angle and only the loose pieces on the surface can be examined. A little farther west the shales are shown to better advantage by the side of the road in front of the house of Mr. Banner Hess, 4 miles west of Hancock. There are but few fossils simply fragments of *Pterochaenia fragilis* (Hall), *Styliolina fissurella* (Hall), *Bactrites aciculus* (Hall) and two or three fragments of *Goniatites* having been found. There are also the usual marks of the trails of animals in the smooth shales. That part of the section in which the transition from the Romney to the Jennings occurs is covered; still the interval is not great and it appears from the examination of the section in the eastern part of Hancock that the Genesee shale is not present. The sandstones in the upper part of the Romney are evidence of shallower water than that in which the greater part of the formation was deposited and perhaps in Washington County the deposit of the Genesee shale pinched out. In the northeastern continuation of this belt in Fulton County, Pa., Professor Stevenson reported Genesee shale "on the west side of Tonoloway Ridge in Bethel Township" and also in the continuation of the Hancock belt "on Tonoloway Creek near the northern edge of Thompson Township," Fulton County.[1]

No. 2. Not far west of Mr. Hess' house, by the side of the road, are slightly coarser fossiliferous and somewhat arenaceous shales containing specimens of *Spirifer mucronatus* (Conrad) var. *posterus* Hall and Clarke, *Productella,* and crinoid segments. Some of these shales are slightly brownish but most of them, at least when weathered, are of a buff to olive color. Interstratified with the shales are shaly to thin bedded sandstones. The dip in places is over 70° but there are small rolls so that it is not uniform. In the upper part of this zone are brownish argillaceous shales and at the top a brownish massive sandstone, some 4 feet in thickness.

[1] T[3], p. 82.

No. 3. Above the sandstones are buff to olive shales in which are fossils as *Productella* and *Schizophoria striatula* (Schlot.), and brownish argillaceous shales interstratified with the olive ones. Toward the upper part of this zone there are some quite massive sandstones at the base of which is one 4 feet thick, then shales occur capped by another sandstone 10 feet in thickness. Next there is a band of mostly red argillaceous shale containing some reddish compact sandstone the layers of which vary in thickness from 6 inches to 1 foot. Near the top is a stratum of olive blocky shale.

No. 4. Succeeding the belt of red shale is a fairly massive sandstone followed by buff argillaceous and very compact shale which splits into quite thick layers. These are much stained with bright red blotches on the weathered surfaces. Farther up the road are thin bedded, olive, argillaceous shales which form the greater part of this zone and extend to the school-house. No fossils were found by the writer but a few specimens were reported by Rowe. From numbers 2-4 of this section Clarke has identified the following species: *Atrypa hystrix* Hall, *Cyrtina hamiltonensis* Hall, *Schizophoria striatula* (Schlot.), *Spirifer marcyi* var. *superstes* Clarke, *Spirifer mucronatus* var. *posterus* Hall and Clarke, *Bellerophon nactoides* Clarke.

No. 5. The shales of this zone are mostly buff in color but they are not well shown along the road. Some distance above the school-house there are reddish fissile shales which are not very thick. The Upper Chemung is covered along the National Road so that the transition from the Jennings to the Catskill formation is not shown. From collections made by Rowe in the vicinity of the school-house mentioned above, Clarke has identified the following species: *Leptodesma naviforme* Hall, *Liopteria bigsbyi* Hall, *Nucula* cf. *corbuliformis* Hall.

No. 6. The Catskill formation is well shown by the side of the road just west of the church and is composed of red shale and sandstones with some layers of greenish sandstone. From the church well toward the top of Sideling Hill are numerous exposures of red argillaceous shales and red sandstones as well as some greenish-gray, massive sandstones and greenish shales all belonging in the Catskill formation, while the hill is capped by Pocono sandstone.

Exposures in Allegany County

Exposure West of Sideling Creek.—After crossing the crest of Sideling Hill there are outcrops of Pocono sandstone on the western side in which, not far below the summit, is a small opening for coal. Lower are numerous outcrops of the red shales and sandstones of the Catskill formation and a thick band of red argillaceous shale is shown just east of the Sideling Creek bridge. One mile west of the creek is a band of somewhat calcareous sandstone in which are fossils mainly *Spirifer mesacostalis* Hall, *Spirifer mesastrialis* Hall, and *Spirifer disjunctus* Sowerby associated with *Sphenotus contractus* Hall and a few other pelecypods. This rock weathers to a rusty-brown rottenstone due to the leaching of the calcareous material. Immediately below the zone of fossils is a red sandstone stratum beneath which are red argillaceous shales. The dip at this locality is 12° N., 70° W. The rocks of this zone belong in the Upper Chemung and it is to be noted that these fossils occur above red rock. As has already been indicated the red rocks in western Maryland occur at different horizons so that it would be impossible to separate formations by the first appearance of red rocks. A better means of classification is that made by the last appearance of fossils considering the rocks below such a horizon as of Chemung age. In this case in the upper part of the Chemung or Jennings formation there will be found bands of red rock which in the western part of the state are confined to the Chemung member of the Jennings formation but in Washington County appears as early as the Parkhead member.

From collections made in the vicinity of Sideling Hill Creek Dr. J. M. Clarke has identified the following species: *Favosites* sp., *Heliophyllum scrutarium* Clarke, *Spirorbis gyrus* Clarke, *Ambocoelia umbonata* (Conrad), *Productella lachrymosa* (Conrad), var., *Spirifer mesastrialis* Hall, *Sphenotus contractus* Hall, *Bellerophon* sp.

Exposure Northwest of Little Orleans.—The rocks in the vicinity of Little Orleans belong in the Jennings and Catskill formations. The road to the northwest of Little Orleans runs along Fifteen Mile Creek for some distance and then climbs a steep hill. The rocks of the lower Jennings formation are exposed in Fifteen Mile Creek, in the vicinity of Little

Orleans. The lower rocks are olive shales interstratified with some rather massive greenish-gray sandstone. The higher rocks contain some fossils as *Ambocoelia umbonata* (Conrad), and *Atrypa reticularis* (Linné). The rocks at this fossiliferous horizon are largely argillaceous shales which weather to an olive or buff color. Toward the top of the hill in the shales and some slightly coarser layers are fossils though at no place are they abundant.

Exposure on Green Ridge.—This section follows the National Road along which there are fair outcrops up the western slope of Green Ridge. The base of the section begins near the lower part of the hill to the east of Fifteen Mile Creek.

No. 1. The lowest rocks are olive to buff, smooth, argillaceous shales with layers of greenish-gray sandstone not more than 6 to 8 inches in thickness. These shales and sandstones belong in the Woodmont member of the Jennings formation. Higher is the first zone of fossils near the top of one of the thicker layers in which are specimens of *Camarotoechia* sp., but the fossils are fragmentary. At this part of the section the lithologic characters remain about the same as in the lower exposure.

No. 2. Lithological appearance of the rocks about the same as in No. 1 but no fossils were found.

No. 3. A zone of somewhat crumbly and mealy shales in layers of which there are numerous specimens of *Camarotoechia* sp., with a few of *Spirifer mesacostalis* Hall. This zone is about 5 feet in thickness.

No. 4. Olive shales interbedded with thin sandstone; fossils rare. This zone extends up to the base of the lowest brownish shales.

No. 5. At the base of this zone are brownish argillaceous shales but most of the rocks are olive to buff shales alternating with thin sandstone. No fossils were found in this zone, which occurs on the highway below the farm house. From the top of this zone for some distance the rocks are concealed (No. 6).

No. 7. The rocks of this zone are composed of shales and thin sandstone to arenaceous, coarse, blocky shales. They weather to a brownish or buff color with patches and streaks of rather bright red due to weathering of the iron contained in the rock. The base of this zone begins a short distance above the farm house and in a thin sandstone layer are

numerous specimens of *Spirifer* with a very high hinge area probably *Spirifer marcyi* var. *superstes* Clarke associated with *Spirifer disjunctus* Sowerby, and numerous specimens of *Ambocoelia umbonata* (Conrad). Some of this sandstone is almost pinkish in color and all of it is much stained and blotched with red patches. The sandstone is fairly hard but the shales in this zone are mostly olive and fissile.

No. 8. Some distance above the stratum containing the numerous specimens of *Spirifers* are brownish argillaceous shales and thin arenaceous layers. The succeeding rocks are mostly olive to buff shales and thin sandstone with an occasional layer of brown shale or sandstone.

No. 9. Almost at the top of Green Ridge is a ledge of brownish-red sandstone and just above are arenaceous shales to mealy sandstone in which fossils occur; as Spirifers, *Lyriopecten tricostatus* (Vanuxem), *Sphenotus contractus* Hall and other pelecypods. In one block containing a specimen of Spirifer is a white quartz pebble, while on the surface are quite large blocks of conglomerate which apparently formerly capped the hill. It will be seen in the description of the sections on Polish Mountain that blocks of a similar conglomerate occur near its summit. The summits of these mountains were undoubtedly originally covered by this Chemung conglomerate which has been nearly removed by erosion. At first it was supposed to form the top of the Jennings formation but in the section west of Cumberland in Jennings Run it is shown that succeeding a similar conglomerate are several hundred feet of rock which still carry Chemung fossils. In the upper part of that zone there are bands of red shales and sandstone of considerable thickness but in the olive shales alternating with the reds are fossils. The higher rocks, either clear red shales and sandstone or somewhat greenish in color and without fossils, are in the Catskill formation. Evidently Dr. O'Harra considered the conglomerate blocks found on Green Ridge as identical with the one in Jennings Run for he wrote that "It [Jennings Run conglomerate] is not well shown on Green Ridge, although there is abundant evidence of its presence, but along the eastern flank of Town Hill [a parallel ridge a short distance east of Green Ridge] it appears to be of considerable thickness." [1]

[1] Allegany Co., p. 107.

Dr. J. M. Clarke has identified the following species from the collections made on Green Ridge: *Ambocoelia umbonata* (Conrad), *Camarotoechia contracta* Hall, *Liorhynchus* cf. *multicosta* Hall, *Spirifer marcyi* var. *superstes* Clarke, *Spirifer mesastrialis* Hall, *Tropidoleptus carinatus* (Conrad), *Lyriopecten tricostatus* (Vanuxem), *Cypricardella gregaria* Hall, *Palaeoneilo constricta* (Conrad), *Sphenotus contractus* Hall, *Tentaculites discissus* Clarke.

Exposure on National Road on Polish Mountain.—Under the Romney formation a section was described beginning at the top of the Oriskany sandstone to the west of Gilpin and extending, probably, to the top of the formation. A ledge of coarse shale to thin sandstone occurs in the eastern part of the hamlet which was considered to be near the top of the Romney, while from that horizon the rocks are covered east to Town Creek on the bank of which the Woodmont member of the Jennings formation is shown.

No. 1. On the bank of Flintstone Creek, however, just south of Gilpin are bluish shales containing an abundant Hamilton fauna. Then the rocks are covered for an interval when black, fissile shales (No. 2) of the Genesee are exposed. These shales are about opposite the old tannery only a few rods above the junction of Flintstone and Town creeks; and the lowest of them, which are rather bluish in color, are more arenaceous than those seen at the other localities but they contain about the same fauna. At the top of the exposure the shales are more argillaceous and quite carbonaceous and also contain more fossils both in number of specimens and species. The dip at this locality is about 30° S. of E. and some 75 feet of shales are exposed.

From the black shales of this locality Dr. J. M. Clarke has identifed the following species: *Buchiola retrostriata* v. Buch, *Lunulicardium crinitum* Clarke, *Paracardium doris* Hall, *Pterochaenia fragilis* (Hall), *Styliolina fissurella* (Hall).

No. 3. On the eastern bank of Town Creek at the National Road bridge are olive to greenish fine argillaceous shales which alternate with thin bedded sandstones from 3 inches to a foot in thickness. Fossils are rare but *Pterochaenia fragilis* (Hall) and *Buchiola livoniae* Clarke were found. About 100 feet of rock is exposed in this outcrop with a dip of 30°

E. and strike N. 32°. Toward the top the shales are more bluish and, in slightly irregular layers of bluish to greenish shales are some fossils as *Buchiola retrostriata* v. Buch, *Pterochaenia fragilis* (Hall), and a small *Orthoceras*. In the upper part of the cut there is a sandstone stratum over 2 feet in thickness with thinner sandstones above, followed by olive shales. The sandstone weathers to a dark brown color on the edges of the outcrop and the shales, frequently, to a yellowish-brown. These rocks are very similar in lithological characters to many exposures of the Portage stage in central, or the Sherburne sandstone in eastern New York. They are referred to the lower part of the Woodmont which forms the lower member of the Jennings formation in Maryland. About 4⅓ miles north of this locality in Southampton Township, Bedford County, Pa., Professor Stevenson described " laminated brown to olive shales " on the road from McLewees' Gap across Polish Mountain which he stated " may be regarded as Portage." [1]

From the Woodmont as exposed from Town Creek along the National Road to the second turn on the lower part of Polish Mountain Dr. J. M. Clarke has identified the following species: *Buchiola conversa* Clarke, *Buchiola livoniae* Clarke, *Buchiola retrostriata* v. Buch, *Pterochaenia fragilis* (Hall), *Styliolina fissurella* (Hall), *Bactrites aciculus* (Hall), *Orthoceras filosum* Clarke, *Probeloceras lutheri* (?) Clarke.

No. 5. On the National Road at the second turn east of Town Creek near the lower part of the western slope of Polish Mountain are fine, olive, argillaceous shales with an occasional thin sandstone stratum. These shales are moderately fossiliferous, containing *Chonetes lepidiformis* Clarke, *Camarotoechia eximia* Hall, *Leptodesma,* and some other species, and breaking into very thin pieces soon crush into powder on the road, although they are used for road material. Up the mountain beyond this point are shales and thin sandstones in which fossils occur infrequently, but about 100 yards above the turn specimens of a small *Spirifer* and large *Camarotoechia* were found.

By the roadside above the second turn is a similar exposure of olive shales with an occasional thin sandstone. Some of these shales are

[1] T[3], p. 205.

blocky and contain, though rarely, a few fossils. About 600 feet above the second turn there are fossils in rather blocky shales which are brownish-gray in color, break into irregular pieces, and a little coarser than most of those in this section. Specimens of *Tropidoleptus carinatus* (Conrad) occur and a few other species. The lithologic characters of this band are more like the Romney than is generally the case in the Jennings formation and the fauna is perhaps a recurrent one of that formation.

No. 7. At the third turn on the road are greenish shales alternating with thin sandstones and near the base is a sandstone of greenish-gray color 2 feet in thickness. Some of the thin, blocky sandstone layers contain fossils and two specimens of *Spirifer disjunctus* Sowerby were found as well as others of *Liorhynchus mesacostale* Hall, *Ambocoelia umbonata* (Conrad), *Cypricardella* and layers composed of small crinoid segments.

This zone is very similar in appearance to many in the Chemung of southwestern New York to which stage it is referred. The presence of *Spirifer disjunctus* Sowerby a characteristic species of the Chemung stage is regarded as proving the correctness of this correlation. Some of the thin sandstones are quite micaceous and split into rather smooth layers. A little higher in green argillaceous shales is a slightly irregular layer in which are numerous specimens of *Ambocoelia umbonata* (Conrad). The exposed rocks from Town Creek up the lower part of Polish Mountain are mainly greenish argillaceous and arenaceous shales alternating with thin sandstones of similar color. There is no sharp line separating the rocks which are referred to the Woodmont and Parkhead and those of the Chemung; but a gradual transition from the lower to the upper members. Rocks containing *Spirifer disjunctus* Sowerby are referred to the Chemung stage and the line of separation between the Chemung and Parkhead is considered as below this zone. The average dip of the rocks is 29°.

No. 8. A little below the fifth turn on the road in somewhat blocky shales, fossils are rare but a few small pelecypods were found. At the sixth turn on the road are fine olive non-fossiliferous argillaceous shales.

No. 9. A little above the sixth turn are olive shales in which an occasional fossil, as *Ambocoelia umbonata* (Conrad) occurs, while a little higher in some rather lumpy shales are quite a few fossils as *Spirifer disjunctus* Sowerby, *Spirifer mesacostalis* Hall, *Productella lachrymosa* (Conrad), and pelecypods. These rocks are mostly green to olive shales with thin bands of arenaceous shale or sandstone. There is not much variation in the lithological appearance of the rocks, and fossils occur only in occasional layers.

No. 10. Between the seventh and eighth turns on the road, about opposite a spring which occurs in a run on the lower side, are somewhat coarser layers, and on thin sandstones are excellent specimens of *Camarotoechia contracta* Hall associated with specimens of *Spirifer mesacostalis* Hall. The rocks above at the eighth turn are very argillaceous olive shales which break into pencil shales.

No. 11. Just below the ninth turn, in thin sandstone layers are numerous specimens of *Ambocoelia umbonata* (Conrad) and *Spirifer disjunctus* Sowerby together with several other species. The rocks are composed of thin sandstones which alternate with the shales and are about the same in general appearance as the fossiliferous layers in the Chemung of southern New York.

No. 12. Near the top of the mountain the shales weather to quite a brownish or rusty color. In some of the layers of thin sandstone a broad form of *Spirifer disjunctus* Sowerby occurs. Quartz crystals were found in a piece of shale while very near the summit of the mountain are layers of thin bedded, rather bluish sandstone with a dip of 15° to 17° E. Loose pieces of conglomerate and grit occur on the side of the mountain near its top and on the crest. All of the pieces found were loose and the conglomerate was not seen in place, although it undoubtedly capped the mountain originally.

In small runs to the south of the National Road are the greenish shales and sandstones of the Chemung and no indication of a conglomerate ledge was seen. The blocks are not numerous and it is probable that their horizon, stratigraphically, is considerably above the highest exposures on the National Road. Some of the blocks on the joint planes

have a smooth fracture, breaking directly across the quartz pebbles, while others have an irregular, rough surface. No jasper pebbles were seen in the blocks and they do not closely resemble the conglomerate that occurs in the vicinity of Oakland and Mountain Lake Park in Garrett County. They do, however, more closely resemble the conglomerate found on Pea Ridge at Mr. John Robinson's in the eastern part of Garrett County. It is evident that Dr. O'Harra correlated these conglomerate blocks with the one of Jennings Run since he stated that "Remnants of the same conglomerate [Jennings Run] are seen along the top of Polish Mountain."[1] Four and one-third miles farther north in Pennsylvania, Professor Stevenson gave the following description of loose conglomerate blocks found on Polish Mountain:

"Fragments of the *Chemung Conglomerate* lie plentifully along the crest of the ridge, but none was seen in place. . . . .

"There is some possibility that the conglomerate seen on the crest of Polish Mountain may belong to the lower one, as the shales seen in the valley bear little resemblance to those overlying the *Upper Conglomerate;* and, moreover, contain many layers with *Ambocoelia gregaria* and impressions of crinoid stems, such as ordinarily characterize the shales holding the *Lower Conglomerate.*"[2]

The Chemung rocks consist largely of greenish, argillaceous and arenaceous shales with bands of greenish to greenish-gray sandstone. The average dip of the Chemung on Polish Mountain is about 20° and the distance from its base to the top of the point south of the National Road one-half mile. An estimate of the thickness of the Chemung exposed on the upper part of this mountain gave 1000 feet.

Farther to the northeast Professor Stevenson in his "generalized section for Fulton County," Pa., gave the thickness of the "Portage flags" as 1400 feet and the Chemung as 2220 feet, making a thickness of 3620 feet to which is to be added the Genesee shale which Professor Stevenson estimated to have a thickness of 200 ± feet near Saxton[3] in the northeastern part of Bedford County making a total thickness of

[1] Allegany County, p. 107.
[2] T^2, p. 205.
[3] T^2, p. 82.

about 3820 feet for the rocks which in Maryland are referred to the Jennings formation.[1] The Jennings formation of Polish Mountain may be followed northeasterly across the eastern part of Bedford County to Professor Stevenson's section "on the Huntingdon and Broad Top Railroad, beginning in Saxton" which gave a thickness of "almost 3400 feet"[2] to which is to be added the 200±feet of Genesee shale[3] making a total thickness of almost 3600 feet.

From the specimens collected in the Jennings rocks on the western slope of Polish Mountain Dr. J. M. Clarke has identified the following species: *Ambocoelia umbonata* (Conrad), *Atrypa hystrix* Hall, *Atrypa reticularis* (Linné), *Camarotoechia contracta* Hall, *Camarotoechia eximia* Hall, *Chonetes lepidiformis* Clarke, *Crania* sp., *Cryptonella* cf. *eudora* Hall, *Dalmanella* sp., *Douvillina cayuta* Hall, *Liorhynchus mesacostale* Hall, *Orbiculoidea* cf. *media* Hall, *Productella lachrymosa* (Conrad), *Productella lachrymosa* (Conrad) var., *Productella speciosa* Hall, *Spirifer disjunctus* Sowerby, *Spirifer marcyi* Hall, var. *superstes* Clarke, *Spirifer mesacostalis* Hall, *Spirifer mesastrialis* Hall, *Tropidoleptus carinatus* (Conrad), *Nuculites* sp., *Schuchertella chemungensis* (Conrad), *Murchisonia ecclesia* Clarke, *Tentaculites discissus* Clarke.

Exposure on Williams Road on Polish Mountain.—This section begins at the intersection of the Williams Road and Town Creek and then follows the road to the top of Polish Mountain, crossing the same zones of the Jennings formation as the section along the National Road and nearly parallel with it but about 2 miles farther south. The road winds back and forth to such an extent that no effort was made to measure the thickness of the rock but there are various well-exposed zones of the Jennings formation which extend from the bank of Town Creek to the summit of the mountain.

No. 2. In the cliff on the eastern bank of Town Creek just below the highway bridge are smooth, argillaceous mainly light olive to bluish, sparingly fossiliferous shales changing to thin sandstones. A few speci-

[1] T^4, p. 75.
[2] *Ibid.*, p. 78.
[3] *Ibid.*, p. 82.

mens of *Buchiola retrostriata* v. Buch and *Bactrites aciculus* (Hall) were found in them and some trails of animals. The rocks are of the Woodmont member and from the lower part of the Jennings formation. The cliff is from 75 to 80 feet in height and the dip apparently between 27° and 28° nearly east.

No. 3. The lower part of Polish Mountain along Williams Road is composed of thin, olive, argillaceous shales with some thin sandstone layers as shown on its western side. In the midst of the shales forming this zone is a buff to olive layer of mealy sandstone 2 or 3 inches in thickness in which are numerous crinoid segments and shells as for example *Spirifer disjunctus* Sowerby, *Spirifer mesastrialis* Hall, *Spirifer mesacostalis* Hall, *Atrypa reticularis* (Linné), *Productella, Chonetes,* and a few other species. This layer apparently contains about the first of the Chemung fauna, for fossils were not found below and the rocks above for some distance are also barren, smooth, olive shales with olive quite micaceous sandstones 6 inches or more in thickness.

No. 4. This is another thin layer containing a few fossils. The stratum is an olive, mealy sandstone several inches in thickness in which are undoubted specimens of *Spirifer disjunctus* Sowerby and *Spirifer mesastrialis* Hall. The association of these two species of *Spirifer* found in zones No. 3 and No. 4 is interesting because in New York such occurrence is rather infrequent. *Atrypa reticularis* (Linné), Crinoid segments and a few other fossils were found. Loose on the surface of the mountain at this locality are frequent blocks of brownish-red sandstone. Brownish-red arenaceous shales and thin micaceous sandstones of similar color interstratified with buff to olive argillaceous shales appear in place at the side of the road only a few feet above the top of the fossiliferous layer of zone No. 4.

No. 5. Reddish fine argillaceous shale by roadside. The color is perhaps more of a brownish-red and not so bright as in the lowest bands of red shale occurring farther west in Garrett County. Above are shales of olive color which weather to a buff.

No. 6. A stratum of quite heavy, compact grayish sandstone which shatters on weathering but still forms a fairly conspicuous ledge by the

side of the road. Below is a considerable thickness of olive argillaceous shale between this sandstone and the lower argillaceous red shales. Specimens of *Spirifer mesacostalis* Hall occur in the more shaly sandstone. A few loose pieces of conglomerate were noticed on the surface.

No. 7. Olive argillaceous shale occurs at the fork of the road, where one turns to the south, and forms the greater part of the rock along the road for some distance below the fork. One piece was found which contained specimens of *Ambocoelia umbonata* (Conrad). The blocks of conglomerate are more common along the side of the road from this part of the section to the summit of the mountain although most of the pieces are small.

No. 8. Thin layers of mealy sandstone containing abundant specimens of *Spirifer mesacostalis* Hall which occurs only a short distance above the fork in the road. The layer is in the midst of olive to buff argillaceous shales and is about 3 inches thick. The *Spirifers* compose a considerable part of this layer and there are also specimens of quite a large species of *Holopea.* The specimens of *Holopea marylandica* Clarke, *Holopea rowei* Clarke, and *Macrochilina pulchella* Clarke which were described by Dr. J. M. Clarke and the locality given as "road over Polish Mountain east of Rush" were from this section and perhaps this zone.

No. 9. Two bands of red shale cross the road above which are fine, olive, argillaceous shales in which are thin layers containing specimens of *Spirifer mesacostalis* Hall, *Ambocoelia umbonata* (Conrad), *Productella* and pelecypods. Large blocks of massive coarse grained sandstone, grayish in color but weathering to brownish-gray occur along the road and on the mountain slope. It is probable that this sandstone occurs in place at about this horizon although a ledge was not seen.

No. 10. Olive shales occur above the loose sandstone, and one block from this horizon contains large numbers of *Spirifer mesacostalis* Hall. There are also thin, gray sandstones, 6 inches or more in thickness interstratified with the shales. This zone is but a short distance below the summit of the mountain. Loose on the top of the mountain near the four corners are numerous small blocks of quartz pebble conglomerate which

apparently once capped Polish Mountain as was stated in the description of the National Road section of this mountain and the same or a similar one, Green Ridge, on the east. This conglomerate does not represent the top of the Jennings formation as is shown by the sections in the western part of Allegany County as well as those of Garrett County. On Polish Mountain are also blocks of loose sandstone containing large numbers of specimens of *Ambocoelia*. Near the summit and on top of the mountain are numerous blocks of this *Ambocoelia* sandstone some of which are 6 inches in thickness.

Exposure East of Cumberland.—By the side of the National Road 2½ miles northeast of Cumberland, to the west of Evitts Creek and Wolfe Mill, are excellent outcrops of the Genesee shale at the base of the Jennings formation. The shale which is very fine, fissile, black in color on a fresh outcrop but weathering to a gray and readily turning into soil, begins some distance above the valley and is exposed along the roadside to the top of the small hill. This is one of the best localities noted in the county for studying the Genesee shale which seems to be the only county in Maryland in which the shale occurs. Fossils are common, perhaps the most abundant species is *Buchiola livoniae* Clarke. Next in order of abundance are *Pterochaenia fragilis* (Hall), *Buchiola retrostriata* v. Buch, *Styliolina fissurella* (Hall), and *Probeloceras lutheri* Clarke (?). This locality is readily accessible from Cumberland and is an excellent place for studying the black, fissile shales at the base of the Jennings formation which the writer has correlated with the Genesee shales of New York.

The complete list of species found at this locality, as determined by Dr. J. M. Clarke, is as follows: *Buchiola livoniae* Clarke, *Buchiola retrostriata* v. Buch, *Lunulicardium crinitum* Clarke, *Paracardium doris* Hall, *Paracardium delicatulum* Clarke, *Pterochaenia fragilis* (Hall), *Styliolina fissurella* (Hall), *Bactrites aciculus* (Hall), *Probeloceras lutheri* Clarke (?).

On the Williams Road, but a short distance southeast of Cumberland, are fossiliferous shales of the upper part of the Hamilton stage of the Romney formation containing specimens of *Tropidoleptus carinatus*

(Conrad), *Spirifer mucronatus* (Conrad), *Palaeoneilo emarginata* (Conrad), and other Hamilton species. Succeeding the Romney formation are finer argillaceous shales which split into very thin layers. In the shales are specimens of calcareous concretions which have been broken and the cracks filled with calcite so that except in regard to size they considerably resemble the septaria of the Genesee shale in New York. The shales contain some fossils as *Buchiola retrostriata* v. Buch, *Bactrites aciculus* (Hall), and a few other species and are in the lowest part of the Jennings formation which is referred to the Genesee shale. As has already been mentioned the stratigraphy of the outcrops on this part of the road is somewhat complicated by faulting and folding.

From these shales on the Williams Road and McKays Hill southeast of Cumberland, Dr. J. M. Clarke has determined the following species: *Buchiola livoniae* Clarke, *Buchiola retrostriata* v. Buch, *Paracardium doris* Hall, *Pterochaenia fragilis* (Hall), *Styliolina fissurella* (Hall), *Bactrites aciculus* (Hall), *Probeloceras lutheri* Clarke, *Tornoceras uniangulare* (Conrad).

Farther east on the road and still higher in the Jennings formation the shales are olive in color and fossils are infrequent. This portion of the formation is correlated with the Portage stage in New York.

Exposure on Jennings Run.—Jennings Run, in the northern part of the county, a tributary of Wills Creek, has cut a deep trench through the eastern face of the Alleghany Front in which part of the formations of the Upper Devonian and Carboniferous are well shown. The lower part of its course is across the Romney formation all of which is covered except its top which is also true for the greater part of the middle portion of the Jennings formation, while several succeeding formations are quite well shown in the narrow part of the gorge. In the section above Corriganville, the upper part of the Romney is shown as has already been described under that formation, but the remaining part of the section was only briefly mentioned. This is an important locality for studying the formations under consideration and the various exposed zones will now be described in detail.

	Thickness.	Total thickness.
No. 1. At the eastern end of the road cut are shales and sandstones of the upper part of the Romney formation, 147 feet shown.		
No. 2. Covered portion	30	30
No. 3. Thin black argillaceous shales splitting into very thin pieces which are even and smooth, and weathering to a slightly brownish tint are excellently shown in this cut, which in many respects is the best exposure of Genesee shale known in Maryland. The shales are quite fossiliferous as for example, *Styliolina fissurella* (Hall) is abundant in certain layers while *Buchiola retrostriata* v. Buch and *Pterochaenia fragilis* (Hall) are not uncommon. This exposure of shale is quite similar to many in the typical outcrops of the Genesee shale in central New York with which it is correlated. The contact between the Genesee and Woodmont is clearly shown and at the top of the black Genesee shales the rocks become coarser in texture and thin sandstones occur alternating with shales. The line of division is drawn where the thin sandstones appear, a little to the east of the sycamore tree near the middle of the upper part of the cut. Within 5 feet there are bands of sandstone 2 to 3 inches in thickness alternating with the shales, and the lithological appearance of the rock is unmistakably that of the Woodmont stage. This is the best exposure of the contact of the Genesee shale and Woodmont shale known in Maryland. From these black shales Dr. J. M. Clarke has identified the following species: *Buchiola retrostriata* v. Buch, *Lunulicardium cymbula* Clarke, *Paracardium doris* Hall, *Pterochaenia fragilis* (Hall), *Styliolina fissurella* (Hall), *Bactrites aciculus* (Hall), *Probeloceras lutheri* Clarke (?), *Tornoceras uniangulare* (Conrad)..................	73	103
To the northeast of this exposure Professor Stevenson reported two outcrops of the Genesee shale in Napier Township in the western part of Bedford County, Pennsylvania.[1]		
No. 4. On a fresh fracture the thin shales have a rather bluish color and alternate with thin sandstones of similar color, both of which weather to a greenish tint and here and there are iron-stained. In the upper part of this zone the sandstones are thicker than in the lower portion; one being 9 inches and several others nearly as thick..	38	141
No. 5. Prominent massive bluish-gray sandstone, which weathers to a greenish tint, 2 feet, 9 inches in thickness. This is the most prominent stratum in the upper part of the cut and may be readily located	2+	143+
No. 6. The shales above are bluish argillaceous and arenaceous, and a little higher mainly greenish shales occur alternating with thin sandstones. The greater part of this upper portion is in the field at a short distance from the road. These rocks are all in the		

[1] T², p. 82.

	Thickness.	Total thickness.
Woodmont member of the Jennings formation. Dip at top of Genesee shales 77°, on the massive sandstone 85°, and in the upper part of the section from 84° to 86°	190+	333+
No. 7. Rocks mostly covered. Thickness estimated as about 2740 feet	2740	3073
No. 8. Exposures in the highway cut about 1½ miles west of Corriganville and directly below a small railroad bridge. In the lower part are brownish-red, micaceous sandstones and argillaceous shales and higher are greenish and yellowish shales and sandstones varying in thickness from an inch to 1 foot	112	3185
No. 9. Mostly very massive thick bedded grayish quartzose sandstone alternating with layers of conglomerate. Some of the largest pebbles are in the upper layers at the western end of the cut although these layers are mainly a brownish-gray coarse grit containing an occasional pebble; but other layers near the center of the mass contain more numerous quartz pebbles and form a conglomerate. The pebbles are mainly white quartz, rounded or flattened in shape and of various sizes up to an inch or more in diameter. Some of the sandstone layers contain Chemung pelecypods and Dr. Rowe found a single specimen of *Spirifer disjunctus* Sowerby, while specimens of small *Tentaculites* and crinoid segments occur. Near the western end of the cut on the surface of thin sandstone layers are specimens of *Sphenotus contractus* Hall. This conglomerate at one time was considered to mark the upper limit of the Jennings formation; but later investigations have shown that it is better to draw the line of division at a horizon several hundred feet higher. It was also considered as occurring near the horizon of the conglomerate which has been noted on top of Green Ridge and Polish Mountain as well as the prominent one in Garrett County which in a general way is probably true, although it is hardly proven that they occur at strictly the same horizon; but they do occur in the upper part of the formation within several hundred feet of its top. The rocks at this locality are quite similar in lithological appearance to many exposures of the upper Chemung in southern and southwestern New York	40	3225

Dr. O'Harra gave the thickness of this zone in Jennings Run as 35 feet and stated that, "It is well marked by a line of hills along the eastern slope of Allegany Front and near the southern end of this line of hills 4½ feet of the bed is shown."[1] About 7½ miles northeast of Jennings Run, in Gladden's Run west of Palo Alto, Bedford County, Pa., Professor Stevenson found a conglomerate which from the context[2] he evidently regarded as the

[1] Allegany Co., p. 107.

[2] T[2], p. 79, where the list of localities of the lower conglomerate in the county is given.

	Thickness.	Total thickness.
one which he called the Upper Chemung and stated that, "The exposure of this rock in place is incomplete, but great masses of conglomerate are strewn thickly over the surface."[1] The occurrence of the Upper Chemung conglomerate at the locality just cited, only 7½ miles northeast of the Jennings Run conglomerate and in the direct line of strike supports the opinion that they are identical.		

In Dr. White's section along the Potomac River to the northwest of Keyser where the same belt of the Jennings formation crosses the river he described two layers of conglomerate in the Chemung about 900 feet apart. The upper one is given as 400 feet below the top of the Chemung and 2 feet in thickness and is described as "composed of very thin, flat, rounded quartz pebbles, in a matrix of coarse rotten sand with numerous fossil shells imbedded" while the lower one is given as 40 feet thick and consisting of "a gray, hard sandstone, containing numerous layers filled with flattish, white quartz pebbles."[2] The interval of 900 feet between these two conglomerates agrees closely with that of 950 feet given by Professor Stevenson as the thickness of the rocks between his lower and upper Chemung conglomerates in Fulton County, Pennsylvania.[3]

The horizontal distance was obtained in part from pacing and also by counting railroad ties parallel to the direction of the section from which was estimated 3225 feet for the thickness of the rocks from the base of the Jennings formation to the top of this conglomerate. Dr. Rowe made the horizontal distance by pacing 3236 feet which with an average dip of 77° gave a thickness of 3140 feet from the base of the Jennings to the top of this conglomerate.

No. 10. For a distance of about 630 feet along the highway are partial exposures of coarse grained micaceous, greenish-gray and brownish-red sandstones alternating with shales. The average dip is about 62° and at the top of the Chemung it is 57°. The greenish to yellowish sandstones contain some rather poorly preserved Chemung fossils, as for example *Spirifer disjunctus* Sowerby and *Spirifer mesacostalis* Hall (?) together with *Grammysia elliptica* Hall and *Sphenotus contractus* Hall. The last of the fossils were poorly preserved and occurred after a considerable thickness of brownish-red rocks had been passed. On Dr. Rowe's section the horizontal distance from the top of the conglomerate to the upper horizon of fossils was 612 feet which with an average dip of 68° gave a thickness of 570 feet for this upper zone of the Chemung..	555	3780

[1] *Ibid.*, p. 99.
[2] Proc. Amer. Phil. Soc., Vol. XIX, 1882, p. 443.
[3] 2d Geol. Surv., Pa., T[2], p. 75.

The thickness of the Jennings formation in this section has been estimated several times and by different observers from which it appears that 3800 feet is not far from the formation's thickness in Jennings Run.

Dr. O'Harra gave the thickness of the zone in the Jennings overlying the conglomerate of Jennings Run as "about 650 feet"[1] and stated that the thickness of the entire formation along Jennings Run "is thought to be between 3500 and 4000 feet."[2] Professor Stevenson estimated the thickness of the Portage and Chemung rocks near Saxton in the north-eastern part of Bedford County, Pa., as "almost 3400 feet"[3] to which is to be added the 200 ± feet of Genesee shale[4] making a total thickness for the rocks representing the Jennings formation of about 3600 feet. It will be observed that the thickness obtained by Professor Stevenson in both Bedford and Fulton counties agrees very closely with the results in Jennings Run.

It is somewhat difficult to decide upon the line of division between the Jennings and Catskill and perhaps in some respects a merging of the colors representing the two formations at their junction would be the more satisfactory way to map them. The lowest appearance of red or brownish-red rocks, which has been used in some instances as the line of division in areal work, is a very variable horizon as has been shown in the accounts of various sections in Washington and Allegany counties. The horizon of the highest fossils which has been taken for the line of division between the two formations is about 550 feet above the grit and conglomerate which has already been described as exposed in the Jennings Run highway cut. In regard to the lithology of the rocks there are plenty of dark red to brownish-red sandstones and shales below the last fossils but it is noticeable that above this horizon the rocks are of a brighter red color and for nearly a thousand feet consist almost entirely of red shales and sandstones.

[1] Allegany Co., p. 107.
[2] *Ibid.*, p. 108.
[3] T^3, p. 78.
[4] *Ibid.*, p. 82.

The conglomerate or grit has also been called the top of the Jennings formation which indicates that there was a change in the depth of water and so a physical modification; but it is not certain that all these conglomerates occur at precisely the same horizon. It is known that in Garrett County there are at least two and probably other horizons. At least the Chemung fauna continues above the conglomerates both in the western part of Allegany County and Garrett County and since this shows that the rocks succeeding a conglomerate for a thickness of about 550 feet are of Chemung age it appears better to class this upper division in the Jennings formation. Succeeding this horizon the rocks are mainly red shales and sandstones which belong in the Catskill formation. The first of the reds begins considerably lower in most of the sections but as long as Chemung fossils occur in considerable abundance the rocks have been classed in the Jennings formation. It will be seen from the above statements that there is a gradual change in lithological appearance between the Jennings and Catskill formations so that it is difficult in this particular to draw a sharp line of division between them. Again there is probably some difference of position in the horizons at which the last Chemung fossils were collected; but upon the whole it is thought that this method of division is the most satisfactory one that can be used in separating these formations.

Exposure on Braddock Run.—Four miles or more south of Jennings Run the Allegany Front is deeply cut by Braddock Run in which gorge in the cuts of the two railroads which follow it, are frequent exposures of the same formations shown in Jennings Run. That portion of the Allegany Front to the north of Braddock Run is known as Piney Mountain, and to the south is Dans Mountain which when seen from the east is the most conspicuous mountain slope in western Maryland. Unfortunately for the geologist it is well timbered and the slope mostly covered so that the several formations composing it are largely mantled. There are from the crest line of both Piney and Dans mountains magnificent views of the country to the south and east, and one of the most favorable and popular localities is known as Dans Rock on Dans Mountain 5 miles southeast of Frostburg.

In the first cut on the Georges Creek and Cumberland Railroad west of the Winchester Road station are greenish shales belonging in the Woodmont member of the Jennings formation. East of this cut the intermediate rocks between the Woodmont member of the Jennings and the Marcellus shales at the base of the Romney formation are largely concealed. No fossils were found by the writer in the shales of this first railroad cut.

In two or three of the following cuts, to the west, are some red shales; but a considerable part of the rock is a friable, mealy sandstone with red streaks and blotches in which fossils are quite rare. These sandstones alternate with greenish to olive shales which are very argillaceous and similar in lithological appearance to those of the first cut.

Another cut in the upper part of the Jennings formation shows bands of red shales, of considerable thickness, in its western part and loose blocks of conglomerate occur which probably came from a stratum near this horizon. The other rocks are mainly olive clay shales and thin bedded sandstones, some of the latter being rather coarse grained, friable, and buff to yellowish in color. In the somewhat mealy sandstones the writer found occasionally poorly preserved fossils as, for example, *Spirifer, Camarotoechia,* and pelecypods. These fossils occur both above and below the red shales. In some of the olive shales are a few specimens of pelecypods.

Near the western end of the trestle the rocks are considered to belong in the Catskill formation which continues to the vicinity of the eastern end of the longer tunnel where the base of the Pocono sandstone is reached. There are covered intervals so that the entire thickness of the Catskill formation is not shown, still this railroad affords a good locality for becoming acquainted with the rocks composing it.

Exposures in Garrett County.

Exposure in Savage River Valley.—The valley of Savage River was examined for some miles north of the mouth of Crabtree Creek; but it is not a very favorable locality for the study of the Jennings formation. For some distance above the mouth of the creek the rocks are mostly concealed, except on the eastern steep bank of the river. About one-third of a mile above the mouth of Bear Pen Run are grayish to greenish-gray arenaceous

shales some of which are coarse and blocky. Smooth, thin shales also occur which are slightly reddish in color and all of these rocks are shown on the banks of the stream. In the grayish shales are some fossils as *Douvillina cayuta* Hall with small pelecypods; but the fossils are not common. The dip at this locality is between 13° and 14° S. E., and the rocks belong in the Chemung stage of the Jennings formation.

Dr. J. M. Clarke identified the following species from this locality: *Chonetes scitulus* Hall, *Douvillina cayuta* Hall, and *Spirifer mesastrialis* Hall.

Lower on the creek, not far up the highway from the river, are quite massive, very hard and compact, greenish-gray sandstones having a tendency to form flagstones. On some of the layers are conspicuous ripple marks which indicate shallow water during their deposition. Loose blocks of conglomerate also occur at this place and there are some shaly arenaceous layers. No fossils were found in place in these sandstones; but in a loose block from about this horizon specimens of *Actinopteria* were seen.

Exposure on National Road.—In the northern part of Garrett County one of the favorable localities for an examination of the Jennings and Catskill formations is along the National Road. It is to be noted that the word *favorable* in this connection means as far as Garrett County is concerned for it may be stated that there are, in general, very few even fair exposures of the Jennings formation in the county. The Catskill is shown to better advantage; still, on account of the absence of fairly continuous sections it becomes a matter of difficulty to give precisely the stratigraphic composition and thickness of either of the formations. This is particularly true of the Jennings formation and will be fully appreciated by one who, being familiar with it in Maryland, has studied the admirable exposures of the Chemung formation in southern New York.

By the side of the road east of Mr. Michel's and west of the chapel are outcrops of olive argillaceous shales with some thin mealy sandstones containing a few fossils as *Spirifer disjunctus* Sowerby, *Atrypa hystrix* Hall, *Productella speciosa* Hall, *Pterinea chemungensis* Conrad, and *Murchisonia* sp., while a large number of pelecypods occur in the thicker layers of this exposure. These rocks alternate with red argil-

laceous shales and thin brownish-red sandstones. Fossils are not abundant, being found only in the thicker layers. This exposure is in the upper part of the Chemung stage. The dip is N. W., and it is on the western side of the anticlinal fold. At the side of the road are loose stones from Mr. T. L. Layman's farm, mainly sandstones a few of which are somewhat calcareous and these contain in certain layers numerous fossils. On weathering the blocks are quite yellowish-brown from the small amount of iron they contain. Among the fossils are *Douvillina arcuata* Hall, *Chonetes scitulus* Hall, *Dictyophyton,* a large number of pelecypods and *Loxonema terebrum* Hall.

On top of a hill just east of Mr. Layman's and about 7½ miles east of Grantsville buff shales occur and thin sandstones in which are a few fossils; but the fossils are rare and do not form layers in the rock. Near the top of the hill are shales varying from brownish-red, argillaceous to those that are thin and arenaceous. The dip is 2° to the east. Both these zones are between the sixth and seventh mile posts west of Frostburg.

From the collections made on the National Road 6 miles west of Frostburg, Dr. J. M. Clarke has reported the following species: *Chonetes scitulus* Hall, *Schuchertella chemungensis* (Conrad), *Spirifer disjunctus* Sowerby. Reported from 5 to 7 miles west of Frostburg: *Atrypa hystrix* Hall, *Actinopteria* cf. *epsilon* Hall, *Leptodesma lichas* Hall, *Leptodesma longispinum* Hall, *Lyriopecten tricostatus* (Vanuxem), *Orthonychia prosseri* Clarke, *Turbo coronula* Clarke. From a few miles west of Frostburg were listed: *Cypricardella* sp., *Cypricardella nitidula* Clarke. In addition the following species were reported but without statement as to the distance west of Frostburg at which they were found: *Atrypa reticularis* (Linné), *Douvillina cayuta* Hall, *Douvillina cayuta,* var. *graciliora* Clarke.

Near the top of the first hill east of the sixth mile post west of Frostburg the rocks are mainly olive, very argillaceous shales. There is an occasional sandy layer in which are pelecypods. One of these blocks shows ripple marks very nicely; while the shales where they were dug out for the road are nearly horizontal. Directly over the summit of the hill, on the eastern side, the rocks in place are mostly

coarser arenaceous shales, in which few fossils occur, varying to thin sandstones although there is some of the clear argillaceous shale. The dip is to the east.

By the side of the road on each side of the crest of this ridge, in the piles of stone drawn from the adjacent fields, are numerous blocks of flat pebble, jasper conglomerate some of which are large, and one measuring 14 inches shows that the stratum reached at least that thickness. Mr. Frank C. Graham, who owns the farm on the northern side of the road to the east of the ridge, stated that in his field he had found blocks which required two men to lift. Still he has never found a solid ledge of the rock in plowing or other work on his farm, which statement is also made by the farmers on the opposite side of the road as well as by others on whose land loose blocks of the conglomerate were found in northern Garrett County. The blocks are particularly numerous in Mr. Graham's field about opposite the house of Mr. Huey McMan and they also occur abundantly on the western part of Mr. McMan's farm as well as on that of the one to the west owned by James Carey. This ridge, the second one to the west of Mr. Johnson's, is to the west of the fifth mile post from Frostburg. On account of the infrequency of the blocks on the lower part of this ridge and the large number near the summit it appears that the stratum crosses the road at this locality with the general strike of the rocks of this region as is shown by the blocks of the same conglomerate near Mr. Baker's on the road from Johnson's to Salisbury which is to the northeast of the National Road blocks.

The color of the matrix of these conglomerate blocks is very generally a rusty brown in which are imbedded numerous white quartz pebbles of varying size and shape. Many of them, however, are distinctly flat and in the joints of the rock have broken with an even, smooth fracture showing that they were held very firmly in the matrix. This is true regarding the small pebbles as well as those of larger size, so that the jointed face of the rock is perfectly smooth, sometimes covered by a thin film of quartz, and there are no projecting pebbles. This is not true, however, in breaking the weathered blocks by hand, for in this case there are frequently projecting ends of pebbles while many of the fractures instead of

being smooth are somewhat rough. This conglomerate has been likened in general appearance to "peanut taffy" which as a comparison is not especially far-fetched. In addition to the white quartz pebbles there are occasional jasper ones some of which are one-half an inch across, and a few of rose quartz. Some of the flat pebble conglomerates in the upper Chemung of southwestern New York, as for example the Panama conglomerate of Chautauqua County, contain jasper pebbles so that it is interesting to find them here.

This conglomerate closely resembles the one in the upper Chemung in the vicinity of Mountain Lake Park and Oakland, and it appears probable that these blocks represent the northeastern extension of that stratum. The blocks of this conglomerate found on the hill west of Avilton, on the National Road and the Salisbury Road show that in northern Garrett County it is fully as prominent as in the vicinity of Oakland and Mountain Lake Park.

Immediately east of the fifth mile post west of Frostburg red argillaceous shales and thin brownish-red sandstones occur. A little farther east are thin bedded greenish sandstones and shales. Some of these sandstones contain specimens of *Spirifer disjunctus* Sowerby, and *Atrypa hystrix* Hall. Specimens of the latter are common and similar to those which appear abundantly near Deer Park except that at this locality there are not such good exposures for collecting. There are a few other fossils but it is not a good collecting place for the rocks are mostly covered by soil. Most of the rocks weather to a yellowish-brown color and some become fairly rotten, while others of a greenish color are much harder and remain firm. The dip is strongly to the east. Near the bottom of the hill are outcrops of olive to buff shales and thin sandstones. In one of the layers of sandstone are large numbers of crinoid stems. Red argillaceous shales succeed the buff ones in which some of the layers are 1 inch thick. The dip is 42° about S. 60° E.

In the field to the south of the road and across the run at the foot of this hill are rather common blocks of a flat pebble conglomerate which also breaks with a smooth fracture across the pebbles; but the writer is not sure whether they are from the one described to the west or not. Associated

with these blocks are others containing clay pebbles as well as those of quartz that do not break with a smooth fracture. Possibly both kinds of blocks are from conglomerates occurring very near the top of the Jennings formation. In conjunction with the conglomerate blocks are numerous ones of reddish sandstone and it is thought that the Catskill formation begins in the lower part of this ridge. On the northern side of the road are numerous blocks of brownish-red sandstone and an occasional brownish-gray block containing Chemung fossils, mostly pelecypods, but no blocks of conglomerate were noticed.

Exposure on Salisbury Road.—On the Frostburg-Salisbury Road, which leaves the National Road on the ridge northwest of Mr. Johnson's is red Catskill soil continuing to the base of the first northwestern slope. At this point there are loose blocks of conglomerate which do not break smoothly across the pebbles and probably come from a thin conglomerate stratum at about the top of the Jennings. On the second slope are loose, somewhat porous, conglomerate blocks of a rather brownish-gray color bearing no resemblance to the conspicuous flat pebble conglomerate. At this point are brownish-red sandstones and greenish shales and sandstones in some of which are Chemung fossils, as *Productella* and a few other brachiopods.

In the second hollow, however, and in the fields, opposite the house of Philip Baker, are numerous loose blocks of the flat pebble, jasper conglomerate. This locality is about 1¼ miles northwest of Mr. Johnson's, 5¼ miles from Frostburg and 1 mile south of the Pennsylvania line. One of the blocks measured 10 inches which shows that it came from a stratum of considerable thickness. There are numerous pebbles of white quartz of fair size, an occasional one from 1 to 1½ inches across, some of rose quartz and a number of jasper. In the lines of jointing these flat, lenticular pebbles are broken with an even fracture making a perfectly smooth surface of rock. The pebbles neither project nor by falling out make pits, so that the plane of the break is as smooth as if the rock were composed of amorphous material. The fracture is so smooth that it may be said to be almost flinty. The matrix is grayish to brownish-gray but much rust stained in many of the blocks from weathering.

This conglomerate in lithologic appearance, manner of breaking, and shape of pebbles resembles fairly well the conspicuous one on the ridges near Mountain Lake Park and Oakland. As already stated it is in the line of strike with the very similar conglomerate described on the National Road and still farther southwest near Avilton To the northeast of this belt, as far as the writer is aware, there is no detailed description of the Upper Devonian rocks in the southeastern part of Somerset County, Pennsylvania. If the line of strike of the Jennings, however, is followed northeasterly across Somerset County, as shown on the various geologic maps of this portion of Pennsylvania, it will lead to the exposure of the Chemung conglomerate described by Professor Stevenson in Juniata Township in the western part of Bedford County. Professor Stevenson called this "the *great conglomerate* of the Chemung"[1] and evidently considered it as representing the one which he named the Upper Chemung conglomerate and reported it as entering the county from Somerset County on the western side of the Savage Mountain anticline. This indicates the possible identity of the flat, jasper pebble conglomerate of Garrett County and Stevenson's Upper Chemung conglomerate of Pennsylvania and it is to be remembered that Dr. I. C. White in his description of what he regarded as the same conglomerate in Huntingdon County called attention to the presence of the "red jasper (?) pebbles."[2]

Numerous loose blocks of, apparently, the same conglomerate occur northwest of Mr. Baker's on the western slope of the hill toward Piney Run. It was also noted on the western side of the anticline on the hill some distance to the northwest of Piney Run, and near the state line the Hampshire formation is reached.

Exposure on Pea Ridge.—To the south of the National Road and west of Savage River is an elevated region known as Pea Ridge, near the northern part of which is the post-office of Avilton. On the western, southern, and eastern sides of this ridge the streams have cut deep and very narrow valleys. This is especially characteristic of the country to the southwest of the ridge and in the region of the Elbow on the Savage River. From

[1] T^2, p. 119.
[2] T^3, p. 93.

the southern part of Pea Ridge there are fine views of the narrow valleys, steep slopes and peaks to the southward.

To the north-northwest of Pea Ridge and Avilton is Walnut Hill which is on the western side of the Devonian anticlinal axis and is composed of the Catskill formation. On the road crossing Walnut Hill from Avilton to Piney Grove the top of the Catskill formation is near the top of Red Ridge and its base is 1 mile northwest of Avilton near McKenzie's store. On the ridge just east of the store are loose blocks of conglomerate in the road in one piece of which a fragment of a fossil was noticed. The rocks in place are brownish-red, rather arenaceous shales near the dividing line of the Catskill and Jennings formations. The blocks of conglomerate resemble, lithologically, the one which has been noticed in several localities very near the top of the Jennings formation, and the yellow soil of the Jennings covers the hill to the eastward. On the road to the southeast are occasional slight exposures of greenish shales and sandstones of the Jennings formation.

On top of the hill just northwest of Avilton are numerous loose blocks of the flat pebble, jasper conglomerate. The field to the south of the road is well covered with numerous blocks of it and also a brownish sandstone which weathers to a very light gray color. The pebbles of this conglomerate on the faces of the blocks are broken evenly so that there is a smooth fracture and the rock in its lithologic appearance closely resembles the conglomerates described on the National Road near McMan's and Graham's and on the Salisbury Road at Baker's. On account of the conspicuous presence of these blocks in the immediate vicinity of Avilton the name *Avilton conglomerate* is proposed for this zone of flat, jasper pebble conglomerate in the Upper Jennings of northern Garrett County. The conglomerate described to the northeast on the National Road near McMan's and Graham's and on the Salisbury Road at Baker's is undoubtedly identical. The white quartz, flat pebble conglomerate described to the south of Avilton on Pea Ridge and the numerous blocks of a similar one found in the Mountain Lake Park-Oakland region and to the south of those towns is correlated provisionally with the Avilton conglomerate.

FIG. 1.—VIEW SHOWING JENNINGS TOPOGRAPHY NEAR LITTLE ORLEANS.

FIG. 2.—VIEW SHOWING RECTILINEAR JOINTING IN THE SANDY SHALE OF THE JENNINGS FORMATION NEAR STOTLERS CROSSROADS.

On the Pea Ridge Road 1½ miles south of Avilton, opposite the house of Mr. John Robinson, is an interesting exposure of a massive conglomerate rock in place and this is the only known locality in northern Garrett County in which this occurs. It becomes, therefore, a place of considerable interest. The ledge is shown by the side of the highway, just west of the house, where it is dipping at a rate of from 34° to 39° S., 60° E. A little lower are numerous large blocks of the conglomerate which on long exposure have weathered to a very light gray color. The rock passes from a quite coarse pebble conglomerate through a grit into a coarse quartzose sandstone. In fact much of the rock really varies from a grit to a fine pebbled conglomerate; but is almost entirely composed of the coarse material like a fine pebble deposit on a recent sea beach. The color on recent unweathered fractures of the rock is rather a rusty brown; but the outside of the blocks on long exposure bleach to a very light gray or almost white. Some of the rock shows layers of pebbles through a coarse sandstone, while some of it is a sandstone containing an occasional pebble. The stratum by the roadside is mainly a sandstone varying to a grit and shows a thickness of at least 3 feet. One block of the conglomerate on the stone crop had a thickness of 20 inches. There are in parts of the rock quite large, flat, white quartz pebbles which have broken with a smooth fracture on the joint surfaces. No jasper pebbles, however, were found and in that particular it does not agree with the Avilton conglomerate. It does, however, resemble quite closely the conglomerate in the upper part of the Jennings formation in Jennings Run. This ledge is on the eastern side of the anticlinal fold and in the line of the strike about N. 35° E. At the second turn of the road to the northeast of Mr. Robinson's are numerous loose blocks of the conglomerate.

Before reaching the first road turning east there are outcrops of greenish Jennings shales which are dipping sharply eastward, and in blocks of loose greenish sandstone on top of the ridge near the corner are specimens of pelecypods. On this eastern road some distance below the summit of the hill is a zone of greenish to greenish-gray micaceous sandstone and olive argillaceous shale in which is a yellowish-gray con-

glomerate. The pebbles are quite small, mostly rounded quartz but they are neither flat nor very numerous and do not break with a smooth fracture. They either project from or drop out of the matrix so that in appearance it differs from that of the conglomerates described from a lower horizon in the formation. This horizon is considered as nearly, if not quite, at the top of the Jennings formation, at which position a similar conglomerate has been noticed in several other localities.

Exposure on Green Glade Run.—Seven miles northeast of Oakland a road passing over Green Glade Run from the southeast to the northwest crosses the belt of the Jennings formation and, although on the opposite side of the glade there are scarcely any exposures, outcrops occur on the hills on each side of the run.

No. 1. Exposures on the north and south road to the east of Green Glade Run and between the road leading to Altamont and the one to Swanton. The outcrops are mostly very argillaceous olive shales stained brown which weather to a rather yellowish color and readily decompose into soil. There are but few arenaceous layers and no fossils were found.

No. 2. Outcrops by the side of the road up the hill to the west of Green Glade Run as far as Maryland Park Place consisting of olive to yellowish-green argillaceous shales with some thin layers of sandstone on which are a few poorly preserved fossils as *Spirifer disjunctus* Sowerby and *Chonetes scitulus* Hall but these species are not abundant. The rocks dip eastward but they are probably on the western side of the axis and it is a reversed dip as is shown on the upper Deer Park Road northeast of Oakland. On the Geological Map of the Piedmont Folio this exposure is near the upper part of the Jennings formation. To the east of the run some red argillaceous shales were noticed by the roadside.

No. 3. By the road on the western side of the first hill to the west of Green Glade Run the rocks are dipping northwest and are composed of micaceous greenish thin sandstones and arenaceous somewhat rusty shales. These sandstones contain some pelecypods and a few poorly preserved specimens of *Spirifer disjunctus* Sowerby. The fossils, however, are not abundant and on the road a little to the east and below this fossiliferous

sandstone are red argillaceous shales while to the west and above the fossils is a band of red sandstone. This locality is about at the line of division between the Jennings and Catskill formations as represented on the Geological Map of the Piedmont Folio.

From zones Nos. 2 and 3 of this section Clarke has identified the following species: *Chonetes scitulus* Hall, *Douvillina arcuata* Hall, *Douvillina cayuta* Hall, *Schuchertella chemungensis* (Conrad), *Spirifer disjunctus* Sowerby, *Loxonema terebra* Hall, *Murchisonia* (?) sp.

The rocks along the road after turning to the north are mainly red shales belonging in the Catskill formation.

Shales occur by the highway on the hill to the southeast of North Glade Run which, buff in color, mealy in texture and quite micaceous, alternate with red argillaceous and arenaceous shales. No fossils were found. The dip is to the northwest and the outcrop is on the western side of the anticlinal axis.

On the road turning north at North Glade are greenish micaceous arenaceous shales varying to thin sandstones. No fossils were found in rocks in place but in some of the loose blocks were plenty of Crinoid segments. Above this outcrop are red argillaceous shales.

On the road from North Glade to Swanton, which crosses the Jennings formation, no fossils were found and very few exposures of rock occur. From the turn, 1½ miles west of Swanton, red shales of the Catskill formation occur along that road toward the town.

Exposure from Ness Lick Run to Altamont.—The Jennings and Catskill rocks of the anticlinal fold which crosses Garrett County from the northeast to the southwest do not form any conspicuous cliffs or ledges in the vicinity of Oakland and Deer Park, still there are, perhaps, the most satisfactory outcrops of the formations in the southern part of the county to be found along the several highways between these two towns. This is especially true as far as the Jennings formation is concerned and although there is not a continuously exposed section for any great distance yet a very fair idea of its composition may be obtained. The exposures are some of the Chemung stage of the Jennings and afford the best collecting to be found in this formation in Maryland. The

characteristic Chemung species *Spirifer disjunctus* Sowerby is common and in places there are beautifully preserved specimens. There is more or less reversal of dip in these outcrops, so that none of them are favorable for determining the thickness of the rocks. One of these sections follows the road northeast from Mountain Lake Park, crosses Ness Lick Run, then the hill by the Mitchell house and continues to Altamont.

Just after crossing the western branch of Ness Lick Run, to the north of Mountain Lake Park, above the point at which the upper Deer Park Road from Oakland joins the Mountain Lake Park Road, are olive argillaceous shales in the gutters by the side of the road and plenty of loose, argillaceous, greenish sandstones. In some of these pieces are fossils, the most common of which is *Ambocoelia umbonata* (Conrad), *Cyrtina* sp. was also found. The soft argillaceous shales weather into clay. There is an occasional piece of quartz conglomerate but the pebbles are quite small. The rocks are exposed in the gutters almost to the top of the hill and are mostly olive to yellowish-green shales. Some of the layers are slightly reddish and others vary from a light gray to almost white.

Near the base of the ridge just west of the Ness Lick Run branch, at the locality just described, are quite large blocks of grayish conglomerate containing some flat white quartz pebbles. Some of these blocks occur in the gutter on the upper Deer Park Road but a short distance above its junction with the Mountain Lake Park Road while to the north of it they have the appearance of a broken down ledge.

Blocks of conglomerate occur to the south of the locality just described on the road from Hotel Dennett in the northwestern part of Mountain Lake Park to Oakland. There are also large blocks of conglomerate on the western side of the small draw not far west of Hotel Dennett apparently the same as those just described to the west of Ness Lick Run. From the blocks found at other localties about on the line of strike with this one it appears that there is a stratum of this conglomerate in the Chemung rocks on the western side of the anticlinal axis which is light gray in color and contains numerous quartz pebbles part of which at least are flat. and on the jointing surfaces of the blocks are broken directly

across so that there is a smooth surface. A similar conglomerate has been found at a number of localities in the vicinity of Oakland and Mountain Lake Park as well as to the south of these towns.

To the northeast of the two localities just described, on the hill crossed by the Mountain Lake Park and Altamont Road, which forms the divide between the branch and Ness Lick Run, are large loose blocks of conglomerate. This locality is on the western side of the axis but, on account of a roll in the rocks, the shales on this ridge, by the side of the road, show a dip to the south of east.

Again on the first road turning to the northwest toward Hoop Pole Ridge there are blocks of conglomerate on the ridge directly west of the crossing over Ness Lick Run which are not large but are, apparently, near the horizon of a conglomerate stratum. Above is a brownish-red, thin bedded sandstone.

The base of nearly continuous reds occurs on this road 2800 feet to the northwest and outcrops of thin bedded sandstone which are 340 feet below the base of these reds give an average dip of 55° N., 40° W. If the dip remained the same for the entire horizontal distance it would make this conglomerate 2300 feet below the heavy reds at the base of the Catskill formation while even a dip of 45° would give a thickness of 1960 feet. It is probable, however, that there are rolls in the rocks or that the dip is less for part of the distance so that this estimate of the thickness is considerably too great. But, 45 feet below the base of the heavy reds on this road is a second conglomerate which is shown in the ditch at the side of the road and there are fairly large blocks of it in the field. The stratum measures from 5 to 7 inches in thickness and it occurs in the midst of yellowish-green shales. There are numerous quartz pebbles in the matrix which are not so lenticular in shape as those in the lower conglomerate and the weathered blocks of the rock are stained a rusty brown color. The average dip of the shales just above this conglomerate is 59° N., 50° W. and the strike is N. 40° E.

The Oakland-Altamont Road crosses a ridge about 1 mile northeast of the road leading to Hoop Pole Ridge, above described, which is the third ridge west of the Mitchell house. The top of this ridge is covered

with numerous quite large blocks of rock varying in texture from a coarse sandstone to a conglomerate. Some of the sandstone blocks contain layers of pebbles and the others vary from those in which part of the pebbles are more than an inch in diameter to a conglomerate composed of small ones. The pebbles, which are largely white quartz, somewhat lenticular in shape, break with a smooth fracture on the joint surfaces. It is evident from the presence of these numerous and large blocks that this ridge was formerly capped by this conglomerate and sandstone. The soil by the roadside up the ridge contains large numbers of white quartz pebbles which have been derived from the decomposition of this rock. In appearance this conglomerate considerably resembles the one described on Pea Ridge in the northern part of Garrett County at Mr. John Robinson's and, to some extent, the flat pebbled conglomerates in the Chemung of southwestern New York. To the west of the road is a considerably higher point on the slope of which are quite large blocks of sandstone containing numerous specimens of a few species of Chemung fossils: *Atrypa hystrix* Hall and *Douvillina cayuta* Hall are especially abundant but other species are associated with them. The conglomerate and sandstones are on the western side of the anticlinal axis where the dip is westerly and as the fossiliferous sandstones are on the ridge to the west of and higher than the conglomerate there is no question but that they occur at a stratigraphically higher position than it. The fauna of the sandstones is very similar to that found at several localities in the vicinity of Deer Park and mostly on the eastern side of the anticlinal axis.

Directly above the four corners along the side of the Altamont Road to the north of Deer Park are exposures of olive shales alternating with thin layers of calcareous sandstones containing fossils. In some of these layers specimens of *Ambocoelia umbonata* (Conrad) are very abundant forming a large part of the rock. There are other layers which contain specimens of *Leptostrophia perplana* (Conrad), var. *nervosa* Hall, *Chonetes scitulus* Hall and *Atrypa hystrix* Hall. Near the top of the hill are numerous blocks filled with specimens of *Leptostrophia perplana* var. *nervosa* Hall indicating that they are, apparently, above the zone in which *Ambocoelia umbonata* (Conrad) occurs so abundantly.

There are exposures on the side of the road west of the Mitchell house 2 miles west of Altamont and on what is known as the Williams farm. In the road ditch on the western side of the hill are numerous pieces of olive to buff shaly sandstone containing abundant specimens of *Leptostrophia perplana* var. *nervosa* Hall and some other species. Some of the thinner and rather harder layers contain pelecypods. Near the top of the hill in some rather sandy shales are numerous specimens of *Chonetes scitulus* Hall. There are also argillaceous shales shown by the side of the road and it is evident that all of these rocks occur in place at this locality. On the small hill to the west are loose blocks of sandstone, part of which are also fossiliferous, and a few blocks of flat pebble conglomerate. The dip of the rocks on this hill is to the east.

The road across the Williams farm was formerly a good locality for collecting fossils but they are now partially exhausted. The species which occurred, though not numerous, were represented by a good many specimens. On top of the hill at the Mitchell house are numerous, unfossiliferous, loose blocks of fairly fine grained, buff to brownish sandstone. This hill is a high point for this region and there is a good view of the mountain peaks to the southwest and northeast.

East of the junction of the Deer Park and Swanton and Altamont roads, about 1 mile west of Altamont, red argillaceous shales are exposed by the road side. To the west of the corners and east of the school-house greenish-gray sandstones are shown but no fossils were found in any of these rocks. On the ridge directly east of the school-house where the road starts down the grade is a thin ledge of conglomerate. The pebbles of this stratum are not conspicuously flattened and, like the one described on the road toward the Hoop Pole Ridge, it probably belongs near the top of the Jennings.

Exposures North of Deer Park.—Other good localities for examining the upper part of the Jennings formation are on the two highways north of Deer Park. Probably the exposure of some 60 feet on the road northeast of Deer Park toward Altamont is the greatest thickness of any one outcrop; the rocks are fossiliferous and it is a good locality for collecting.

An exposure occurs on the northeast side of the highway from Deer Park to Altamont in descending the hill toward the small run. The rocks are shown in place and consist of olive shales and thin gray sandstones which alternate with three zones of red argillaceous shales, the middle one being partly arenaceous and about 5 feet thick. There are certain layers of the rock which contain large numbers of *Spirifer disjunctus* Sowerby, *Productella lachrymosa* Hall, and other fossils. The lowest reds are at the base of the small hill so that all the specimens of fossils occur above red shales. This exposure, which is mapped on the geological map of the Piedmont Folio as at the base of the Catskill formation, is clearly in the Chemung after the appearance of the red shales and is a favorable one for studying the Chemung fauna. About 60 feet of rocks are exposed, the greater part of which consist of olive colored, argillaceous, blocky shales.

Along the highway to the north of Deer Park are some exposures of Chemung rocks but they are mostly concealed. In the stone walls are numerous pieces of rather flat, thin bedded sandstone containing fossils which evidently came from the adjacent fields. Some of the rocks are not fossiliferous and others only contain layers of Crinoid segments. These rocks are about west of the locality which has just been described to the northeast of Deer Park. Farther north on the road from Deer Park station loose pieces of sandstone which contain large numbers of *Douvillina cayuta* Hall and some specimens of *Camarotoechia* occur by the side of the highway and in the field. In Garrett County *Douvillina cayuta* Hall and *Leptostrophia perplana* (Conrad), var. *nervosa* Hall are, apparently, the first abundant species in the Chemung fauna. On the road to the south was a little red shale which, probably, occurs below the fossiliferous layers.

From the collections made in the vicinity of Deer Park, mainly from the exposure by the roadside just northeast of the village and from the side of the road running north from Deer Park station and the adjacent fields, Dr. J. M. Clarke has identified the following fauna, which is one of the most extensive found in the Chemung rocks of Maryland: *Ambocoelia umbonata* (Conrad), *Chonetes scitulus* Hall, *Douvillina arcuata*

Hall, *Douvillina cayuta* Hall, *Douvillina cayuta graciliora* Clarke, *Leptostrophia perplana nervosa* Hall, *Schuchertella chemungensis* (Conrad), *Productella speciosa* Hall, *Schizophoria striatula,* var. *marylandica* Clarke, *Spirifer disjunctus* Sowerby, *Leptodesma agassizi* Hall, *Leptodesma lichas* Hall, *Leptodesma longispinum* Hall, *Cypricardella marylandica* Clarke, *Cypricardella nitidula* Clarke, *Palaeoneilo constricta* (Conrad), *Palaeoneilo filosa* (Conrad), *Pterinea nodocosta* Clarke, *Schizodus chemungensis* var. *quadrangularis* Hall, *Sphenotus contractus* Hall, *Murchisonia ecclesia* Clarke, *Palaeotrochus praecursor* Clarke, *Tentaculites discissus* Clarke.

On the ridge to the west of the road leading north from Deer Park station which is crossed by the upper one from Deer Park to Mountain Lake Park, are numerous large blocks of conglomerate. These blocks are on the western side of the ridge facing Ness Lick Run and in lithological appearance are similar to those which occur on the other side of the run. To the south on the same side of the ridge are numerous blocks of flat pebble conglomerate by the side of the lower or new road from Deer Park to Mountain Lake Park. The blocks are more conspicuous near the top of the ridge and on the upper part of its western slope. The late Mr. Robert H. Gordon reported that to the south of this road on his grounds the conglomerate was shown in place in excavating for a building. This line of blocks on the ridge to the east of Ness Lick Run seems to show a continuous stratum of the conglomerate, which is apparently on the eastern side of the anticlinal axis.

Exposure Northeast of Oakland.—The section giving the greatest nearly continuous exposure and thickness of the Jennings and Catskill formations is that on the upper Deer Park Road beginning about 2 miles northeast of Oakland and following the road southwest into the edge of the town. The lower rocks contain plenty of Chemung fossils; then there is a considerable thickness with alternation of red and olive colored rocks, finally terminated by about all clear red shales and sandstones of the Catskill formation.

No. 1. Exposures above thin sandstones and shales on the upper Deer Park Road 2 miles northeast of Oakland. In some of the layers are

numerous specimens of *Douvillina cayuta* Hall, similar to those on the road north of Deer Park, and a few other species were noticed. A few thin bands of red shales were seen alternating with the buff shale and the zone is near the transition from the clear olive shales to the alternation of red and olive shales. To the east of this zone are the blocks of the flat pebble conglomerate as shown on this road directly west of the branch of Ness Lick Run. As far as shown at this locality the rocks are all dipping westward so that the fossiliferous horizon is, stratigraphically, considerably above that of the conglomerate.

No. 2. Directly above the house and bend in the highway, and a little farther west than the fossiliferous zone described above are buff to greenish thin sandstones which become hard on weathering and contain fine specimens of *Spirifer disjunctus* Sowerby and *Atrypa hystrix* Hall with some other fossils especially *Schizophoria striatula*, var. *marylandica* Clarke; but the first two species are the abundant ones of this zone which is near the top of the ridge about three-fourths of a mile west of the intersection of this road and the one north of Mountain Lake Park. The section is similar to those north of Deer Park and shows in its lower part the zone with abundant specimens of *Douvillina cayuta* Hall and higher, the one with abundant specimens of *Spirifer disjunctus* Sowerby. The rock is stained here and there with red and yellowish spots. The blocks containing fossils extend to the top of the hill at the eastern edge of the woods and loose in the field just east of the woods are quite large blocks of greenish-gray sandstone, weathering to a rusty color, in which are some fossils though not nearly as many as there are a little lower on the highway. These blocks, however, still contain specimens of *Spirifer disjunctus* Sowerby and the rocks to the top of this ridge clearly belong in the Chemung stage of the Jennings formation.

No. 3. On the western side of the hill the rocks are not continuously exposed to the valley of the small run but for part of the distance they dip to the southeast, showing a reversal of the dip, and this renders it difficult to make any careful estimate of their thickness. There are outcrops of olive, argillaceous shales and sandy layers with thin bands of red shale. In some of the blocks fossils were found, as, for example,

very broad specimens of *Spirifer disjunctus* Sowerby, *Atrypa hystrix* Hall, *Productella* and the type specimen of *Palaeaster clarki* Clarke.

From these three zones on the road northeast of Oakland Dr. J. M. Clarke has described the following fauna: *Palaeaster clarki* Clarke, *Ambocoelia umbonata* (Conrad), *Atrypa hystrix* Hall, *Atrypa reticularis* (Linné), *Chonetes scitulus* Hall, *Cyrtina hamiltonensis* Hall, *Douvillina cayuta* Hall, *Douvillina cayuta* var. *graciliora* Clarke, *Leptostrophia perplana* var. *nervosa* Hall, *Schuchertella chemungensis* (Conrad), *Schizophoria striatula,* var. *marylandica* Clarke, *Spirifer disjunctus* Sowerby, *Leptodesma longispinum* Hall, *Pterinea nodocosta* Clarke.

No. 4. Exposures on the eastern slope of the hill to the west of the run where the dip is northwest and the rocks consist principally of olive shales, thin bedded greenish sandstones, a cornstone and some red shales. Small blocks of quartz pebble conglomerate occur loose in the field and the thin stratum was found in place by the side of the road. This conglomerate is similar to the thin one found to the northeast on the road toward Hoop Pole Ridge. Not much higher are red shales and sandstones near the farmhouse. The only fossils seen were segments of crinoid stems.

No. 5. On the western slope of this hill toward the second run, and east of the road fork near Oakland are greenish shales varying to thin bedded sandstones near the top of the ridge. Lower are mainly red shales and sandstones which extend to the bottom of the hill. The sandstones are thin bedded and in a stratum of greenish sandstone near the base of the section of nearly continuous red rocks a fragment of a fish scale was found. These rocks, apparently, belong in the Catskill formation although on the opposite side of the run a few fossils were found. It is not perfectly clear, however, that this is a continuous section and the fossiliferous layer, perhaps, is not above the zone of red rock.

No. 6. On the eastern slope of the hill after crossing the small run west of the old mill are, mainly, greenish, coarse grained, micaceous sandstones in the lower part of which a few fossils were found as, for example, *Camarotoechia* and pelecypods. Higher, sandstones alternate with greenish shales while still higher are reddish rocks. On top of

the ridge in the edge of Oakland the rocks consist entirely of red argillaceous shales. This section along the road from Oakland toward Deer Park is an excellent one for studying both the lithological characters and fauna of the Jennings and Catskill formations.

Exposures on Trout Run.—Mountain Lake Park on an east and west line is near the middle of the Jennings belt which, to the south of the Little Youghiogheny River, extends southwesterly into West Virginia. The Jennings formation is flanked on each side by the Catskill formation, in the same manner as from Mountain Lake Park northeast to Pennsylvania. On the Jennings area well toward the West Virginia line are the two localities known as Sunnyside and Red House.

About south of Mountain Lake Park is Trout Run, the lower course of which is a sluggish stream, flowing through glades, without exposures of rocks. On the ridges, however, on each side of the run are at first loose blocks of stone and then ledges in place.

No. 1. On the ridges along Trout Run are plenty of loose blocks of the Jennings conglomerate and grit rock frequently mentioned in the sections on the northern side of the river. On the ridge directly south of the first Trout Run crossing are numerous large blocks of this conglomerate and grit which must have, formerly, capped it. Under the conglomerate, apparently, are olive, mealy sandstones. The soil along the highway contains numerous specimens of white quartz pebbles which have come from the decomposition of the conglomerate. A part of this coarser rock is similar to a typical coarse grit while other pieces contain large numbers of quite large pebbles which are smooth showing that they are water worn. Some of the white quartz pebbles are quite flat, suggesting somewhat the flat pebbled conglomerates of the upper Chemung in southwestern New York. There are also large clay pebbles which on weathering leave holes in the rock resembling slightly the impressions of fossil shells. The only fossils found, however, were impressions of wood.

No. 3. On the highway 3 miles south of Mountain Lake Park and near the top of the second hill south of Trout Run, reddish shales show in the gutters by the roadside. This is on the farm now owned by Mr. Beckman, known as the "old Billy White place." Loose by the side of

the highway are numerous pieces of sandstones containing abundant fossils as, for example, *Spirifer disjunctus* Sowerby, *Atrypa hystrix* Hall, and pelecypods. There are also dark red sandstones which contain numerous specimens of pelecypods similar to *Actinopteria,* together with a few Brachiopods. These fossiliferous rocks are stratigraphically above the conglomerate which was described on top of the first ridge. Some of the fossiliferous sandstone is a greenish color, very hard before weathering and, apparently, calcareous. This is about at the line of division between the Catskill and Jennings formations as represented on the Geological Map of the Piedmont Folio.

No. 4. On the third ridge to the south of Trout Run, just after crossing a small stream but before reaching the highway turning to the west, are buff, coarse, mealy shales at the base of the hill. Higher are red argillaceous shales and still above these, but loose on the road, are blocks of buff to greenish sandstone containing Chemung fossils, as *Spirifer disjunctus* Sowerby and some other species, most of which are pelecypods.

From the above-mentioned outcrops in the Trout Run region Dr. J. M. Clarke has identified the following species: *Atrypa hystrix* Hall, *Atrypa reticularis* (Linné), *Douvillina cayuta* Hall, *Productella hystricula* Hall, *Productella lachrymosa* (Conrad), *Spirifer disjunctus* Sowerby, *Murchisonia* sp., *Murchisonia ecclesia* Clarke.

Exposures on Cherry Creek.—Farther southwest Cherry Creek flows northwesterly across the Jennings and Catskill formations; but for the greater part of the distance across the Jennings the country is flat with few outcrops. In the upper part of its course, however, on the foot hills of Backbone Mountain are exposures by the side of the highway but the other rocks are largely covered by talus. Along the side of the highway to the south of the east fork of Cherry Creek are olive to buff shales and sandstones. Interstratified with these rocks are some reddish argillaceous shales. In the olive shales and in layers of the sandstones are numerous specimens of Chemung fossils as *Atrypa hystrix* Hall, *Chonetes scitulus* Hall, *Leptostrophia perplana* var. *nervosa* Hall, *Schuchertella chemungensis* (Conrad), *Schizophoria striatula,* var. *marylandica* Clarke, *Spirifer disjunctus* Sowerby.

This fauna is similar to that on the Williams farm 2 miles west of Altamont. There are some of the very argillaceous shales in which fossils rarely occur. This zone is at the base of the Catskill formation as represented on the Piedmont Folio and, probably, is stratigraphically higher than the Chemung conglomerate.

There are red shales alternating with olive by the side of the road after crossing the upper part of Cherry Creek not far north of Bownan's Corners. Only a few specimens of imperfectly preserved pelecypods were found in some of the thicker sandy layers. The dip is heavy between south and southeast.

Exposure at Red House.—Perhaps the best section of the Jennings formation in the southwestern part of Garrett County is the outcrop on the Northwestern Pike from Bownan's Corners west toward Red House. Catskill rocks are shown on the pike to the east of the Corners and on the lower part of the western slope of Backbone Mountain. The first fossils were found west of the Corners. Bownan's Corners are formed by the junction of the road from the north with the pike which is the one along which the outcrops described for the upper part of Cherry Creek occur.

No. 1. Shales and thin sandstones by the roadside a short distance west of Bownan's Corners. The first rocks are brownish-red to red argillaceous shales and thin sandstones, alternating with olive shales; but farther west on the road they are all olive argillaceous shales, some of the layers of which are quite porous. This part of the Jennings formation seems to correspond with the "ochre division" of Rogers as described in his Annual Reports of Virginia. In the mealy layers fossils are quite abundant as, for example, specimens of *Spirifer disjunctus* Sowerby, *Atrypa hystrix* Hall, *Douvillina cayuta* Hall, and especially the variety of this species described by Dr. J. M. Clarke under the name of *graciliora* which is abundant, together with some pelecypods. Above the red shales some that are yellowish have bright red blotches and in the coarser of these layers are specimens of *Spirifer disjunctus* Sowerby and other fossils.

No. 2. On the hill at the four corners southwest of Sunnyside are olive shales and thin sandstones by the side of the road but no fossils

were found. The dip has changed at this locality and is steeply toward the northwest showing that the rocks are on the western side of the anticlinal axis. The lithological appearance of these rocks is similar to that of the more unfossiliferous layers of the Chemung stage of the Jennings formation. From exposures, however, about 2 miles south of Oakland specimens of *Douvillina arcuata* Hall, *Strophonella* cf. *reversa* Hall, *Productus* (*Marginifera*) *hallanus* Walcott, and *Leptodesma rogersi* Hall were collected.

Blocks of the white quartz, flat pebble conglomerate occur at several localities between Sunnyside and Oakland.

THE CATSKILL FORMATION

INTRODUCTORY

In Darton's account of the Devonian formations of central Virginia he says that "The Hampshire formation has yielded only a few plant remains which throw no light on the equivalency of the formation, but no doubt it comprised the representatives of the Catskill in their entirety or in greater part."[1] As stated by Darton fossils are rare in this formation as is the case in the corresponding one in Pennsylvania and New York; but the lithologic appearance and stratigraphic position agree, in general, with those of the Catskill formation which has been shown to be a local one in New York scarcely represented in the southwestern part of the state while in the southeastern or Catskill Mountain region it has replaced all of the Chemung and the greater part of the Portage of western New York. It has been further shown that to the east of the Susquehanna River, in New York, the red rocks at first are interstratified with those which contain Chemung fossils, while farther east the red and greenish shales and sandstones replace all the rocks with the lithologic characters of the Chemung and its fauna disappears. Below the Chemung and in the midst of what corresponds to the Portage stage of western New York is another mass of red and greenish shales and sandstones, called the Oneonta formation which extends west of the Chenango Valley.

[1] Amer. Geol., Vol. x, 1892, p. 18.

In Delaware County the upper reds of the Oneonta and the lower of the Catskill unite and, in the Catskill Mountain region, extend downward into what is called the Sherburne sandstones which represent the lower part of the Portage stage of western New York. In Pennsylvania, on following this mass of red rocks to the southwest it is found that they gradually begin later and that the faunas of the Portage and Chemung stages reappear as is the case in the southern part of western New York.[1]

In the lower part of the Catskill formation the rocks consist of brownish-red sandstones alternating with thick bands of red argillaceous shale, while there are occasional thin bands of greenish shale. In these rocks the red sandstones predominate and in some regions make good farming lands, as about Accident in Garrett County. In the upper part of the formation there is a greater thickness of greenish-gray sandstone and shale, alternating with red rocks of similar lithological composition. The greenish-gray rocks increase in amount from the middle to the top of the formation, while near the top the reddish sandstones have more of a brownish tinge than those of the middle and lower part of the formation. The sandstones are conspicuously micaceous, cross-bedded structure is not infrequent and in some localties there is a rapid horizontal change from sandstone to shale deposits or the reverse. The soil formed by the decomposition of the Catskill rocks is of brick-red color contrasting sharply with the yellowish soils of the subjacent Jennings or the superjacent Pocono formations. Fossils are very rare in this formation, the only shells found being some very imperfectly preserved pelecypods from the Baltimore and Ohio Railroad above Frankville and in the railroad cut just east of Altamont; while worm trails and borings have been found at several localities. Some of the best places for studying this formation are in Jennings Run above Corriganville where nearly its entire thickness is shown; along the road down Warnick Run northwest of Lonaconing and along the Baltimore and Ohio Railroad above Frankville. In Washington County the Catskill is about 3800 feet thick.[2] In

[1] 17th An. Rep. State Geol. [N. Y.], in which the writer has discussed this question.

[2] Pawpaw-Hancock Folio U. S. Geol. Surv., 1912, p. 13.

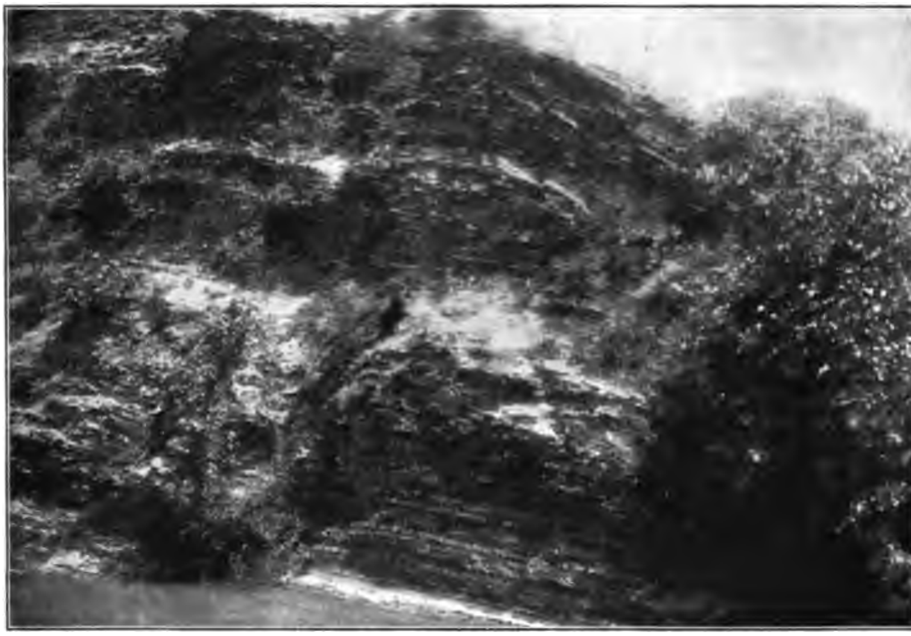


FIG. 1.—VIEW SHOWING THE WOODMONT SHALES ON TOWN CREEK, EAST OF GILPIN.

FIG. 2.—VIEW SHOWING THE CONTACT OF THE GENESEE AND WOODMONT WEST OF CORRIGANVILLE.

Jennings Run it covers about 2000 feet and the result of several measurements indicates that the formation is between 1900 and 2000 feet in thickness. In the eastern part of Garrett County Dr. Martin stated that "The thickness of the formation varies from 1800 to 2200 feet" but decreases toward the west and in the western area "is about 1200 or 1400 feet."[1] The Catskill formation represents at least part of the Catskill formation of New York and No. IX of Pennsylvania.

DISTRIBUTION OF THE CATSKILL FORMATION

From Pigskin to Timber Ridge a belt of the Catskill formation, varying from 1½ to 1¾ miles in width, crosses the state from the northeast to the southwest.

A belt of the Catskill formation crosses the state, east of Sideling Hill, varying from a mile to 1¼ miles in breadth, extending well up the slope. The upper part of Sideling Hill is composed of the Pocono formation while on the western slope is another parallel belt of the Catskill formation, about a mile in breadth, crossing the state and, for part of its distance, extending as far west as Sideling Hill Creek. These two belts may be called the Sideling Hill Catskill areas.

Finally, the extreme northwestern corner of Washington County is covered by the Catskill formation, which belongs in the belt of this formation situated just west and parallel to the Sideling Hill Creek area of the Jennings formation.

In Allegany County the Catskill forms a broad belt on each side of Town Hill and outcrops in a linear area on the east slope of the Alleghany Front.

In Garrett County it flanks the Jennings on both sides of the Oakland anticline and outcrops in a large elliptical area in the center of the Accident anticline, near Accident.

Exposures in Allegany County.

Exposure on Jennings Run.—The cuttings for the highway from the top of the Chemung up Jennings Run afford an excellent series of exposures of

[1] Garrett Co., p. 89.

the Catskill formation. This is one of the best exposures of the formation in Maryland and nearly all its layers are shown in a continuous section. The dip varies from 62° at the base of the formation to about 30° at its top which is near the farm house at the upper end of the narrow part of the gorge.

The lower rocks of the Catskill formation, immediately succeeding the zone with Chemung fossils at the top of the Jennings formation, are brownish-red to red sandstones alternating with thick bands of red argillaceous shale. The lower half of the formation consists of nearly all red sandstones and shales, sandstones predominating, and there are but few bands of rather thin greenish shales. In the upper half of the formation coarse greenish-gray sandstones appear in the lower part in rather thin bands alternating with the reddish rocks; but in the upper portion there are thick zones of both greenish-gray sandstones and shales. Some of the reddish sandstones also are more of a brownish-red color near the top of the formation. All of the sandstones, as a rule, are very micaceous and there is considerable cross-bedding. In general, it is to be noted that in this section the reds, below the fossiliferous zone at the top of the Jennings formation have a rather brownish tinge; then the lower part of the Catskill is composed of quite red sandstones and shales, while in the upper half of the formation there are zones of greenish-gray sandstone and shales of considerable thickness with brownish-red sandstones near the top. The Catskill formation at this locality was measured, from the base upward, by Dr. Rowe who estimated the thickness of the section in three divisions as follows:

Horizontal distance.	Average dip.	Thickness.
1097	62°	965
838	54°	679
753	31°	391
Total 2688		Total 2035

Dr. O'Harra gave the thickness of the Catskill for this section as 1900 feet.[1] The above thickness agrees very well with that of the Catskill to the west of Hyndman, Bedford County, Pa., which is about 10 miles

[1] Allegany Co., p. 109.

northeast of Jennings Run, where it was determined by Professor Stevenson as 1980 feet.[1] Dr. White in his section along the Potomac River gave the thickness of the Catskill as 1300 feet.[2]

Exposure on Braddock Run.—The Catskill is exposed in the cuts of the Cumberland and Pennsylvania R. R. west of Allegany Grove.

No. 1. An estimate of the thickness of the Catskill formation was made which was measured by zones. The first one is from the western end of the trestle to the eastern end of the second cut; the horizontal distance is 900 feet, determined by counting the rails as in all the zones, but the general direction is N. 10° E. so that the distance for measuring the thickness is only about 378 feet. The dip is 60° which gives a thickness of 327 feet for this zone.

No. 2. Extends from the east end of the above cut to the eastern end of the tunnel in the Catskill. The dip at the east end of the cut is 60° to 63°, average 61°, and at the western end 71°, making an average dip, for the cut, of 66°. Horizontal distance 510 feet which would give a thickness of 464 feet but on account of a heavy curve in this zone this would be an overestimate. The general direction, however, from the base of this zone to the top of the formation is nearly at right angles to the strike. The rocks are red shales and sandstones, except at the eastern end where there are some greenish-gray sandstones.

No. 3. The Catskill tunnel, dip at eastern end 62°, at western end 64°, average dip for tunnel 63°; horizontal distance 390 feet, giving a thickness of 347 feet for the tunnel.

No. 4. From the western to the eastern end of the cut is 420 feet horizontal. Dip in cut 52°, making an average dip of 58° and giving a thickness of 357 feet for the zone. The rocks at the western end of the tunnel are largely brownish-red sandstones which are quite massive.

No. 5. This zone runs from the eastern end of the first cut east of the Pocono tunnel to the grayish Pocono sandstones at the eastern end of the tunnel. The rocks consist largely of red argillaceous shales alternating with quite massive, brownish-red, micaceous sandstone. In the

[1] T^2, 1882, pp. 73, 103.
[2] Proc. Amer. Phil. Soc., Vol. XIX, 1882, p. 443.

red shales are occasional thin bands of bluish to greenish shale from a fraction of an inch to an inch or more in thickness; while at the western end of the cut are some greenish-gray rather shaly sandstones. The average dip of the Pocono sandstones at the eastern end of the cut is 50° which gives an average dip for this zone of 51°. Horizontal distance is 1066 feet which gives 832 feet for the thickness of the zone. The sum of these five zones gives 2327 feet as the thickness of the Catskill formation. This, however, is too great for there are some curves on the road and the horizontal distance is not a straight line.

From the base of the second zone, the distance was paced to the base of the Pocono sandstone, avoiding as much as possible the curves in the road, and this gave a horizontal distance of 2175 feet; while the distance determined from the railroad rails is 2386 feet. The average dip for this distance is 59½° which would give a thickness of 1870 feet which, plus the 327 feet of the first zone makes a thickness of 2197 feet for the formation. This is only 162 feet greater than the thickness obtained for the Catskill formation in Jennings Run and is probably not seriously in error.

Exposures in Garrett County

Exposures at Frankville and Crabtree Creek.—Frankville is a station on the Baltimore and Ohio Railroad 8 miles northwest of Piedmont. The railroad follows the western side of Back Bone Mountain up Crabtree Creek until the divide between the creek and the Little Youghiogheny River is reached in the vicinity of Altamont where the highest point of the Baltimore and Ohio Railroad, 2620 feet A. T., occurs and between Frankville and this locality there are numerous cuts on the railroad, affording an excellent opportunity for the examination of the Catskill formation. The prevailing color of the rocks along the track for 2 miles above Frankville is red, and they consist mainly of shales and sandstones, the shales predominating. There are, however, in places some pure argillaceous shales of olive color which weather to a slightly buff tint and some that are rather arenaceous. In one of these zones, perhaps one-half mile above Frankville, part of a pelecypod shell was found. There is also occasionally a calcareous stratum which is a sort of cornstone. The

various railroad cuts show excellently the irregular nature of the bedding in these rocks, for the sandstones often appear as lenses which replace for a distance of several rods a thickness of from 10 to 20 feet of red shales. On the other side the shales will then reappear, and the sandstones are, apparently, evidence of strong currents which eroded channels in the soft shales that were later filled by sands. If this interpretation be correct these sandstone lenses are fine examples of channel filling. The rocks in some of the cuts are mainly sandstone with a thickness of 25 feet; but as a rule there is a greater amount of red shale which is often banded by olive colored zones. Some of the sandstones are of a greenish-gray color. These rocks are in the upper portion of the Catskill formation.

Two miles above Frankville in the bed of Crabtree Creek which is about 115 feet lower than the railroad track, are red sandstones. On the path up the bank is, apparently, a great deal of red argillaceous shale while in the railroad cut opposite this locality the sandstone is mostly greenish-gray in color and in it is a calcareous stratum or breccia.

Spring Lick Creek enters Crabtree Creek from the north and near the top of the hill on the road up Spring Lick is a ledge of faintly reddish sandstone. This stratum is about 740 feet above Crabtree Creek and 3½ miles from Frankville. The road from Crabtree Creek follows Spring Lick Run to the top of the mountain about 4½ miles from Frankville. On the lower part of the mountain are red shales and sandstones with some beds of coarse gray sandstone, all belonging in the Catskill formation; but about two-thirds of the distance from the bottom are coarse bluish-gray sandstones containing an occasional specimen of *Grammysia*. Higher, an occasional poorly preserved *Spirifer* was found; and well towards the top of the mountain in much decomposed buff colored argillaceous sandstones are fine specimens of *Spirifer disjunctus* Sowerby, *Productella, Camarotoechia, Schuchertella,* and pelecypods. Olive shales occur along the roadside on the summit of the mountain and no fossils were found. The top of the mountain is 880 feet above Crabtree Creek and the rocks belong in the Jennings formation.

On the eastern bank of Savage River some distance below Bear Pen Run and opposite a school-house is a conspicuous cliff in the lower part of

which are bluish to greenish-gray arenaceous shales and massive very compact greenish-gray sandstones. Higher are red micaceous sandstones. On the surface of the layers are numerous ripple marks, raindrop impressions and a great variety of mud flows, cracks and, perhaps, the trails of animals. These markings show very clearly the shallowness of the water when the rocks were deposited which are probably in the Catskill formation. A little below the above-mentioned cliff are massive, micaceous red sandstones which extend down the river to the vicinity of Crabtree station. These red rocks are of course in the Catskill formation.

Exposures on the National Road West of Frostburg.—The exposure begins on Red Ridge to the east of Piney Grove probably somewhat east of the road summit, although the exact position is not fixed because the contact with the Pocono sandstone is concealed. On the lower part of this ridge to the west of Two Mile Run are a few thin bands of yellowish-green shale but the rocks are mostly red shales, some of which are quite arenaceous. The soil and road are decidedly red from the disintegration of these shales, and they are typical exposures of the Catskill formation somewhat below its top. The dip is 20° N., 65° W. The hill to the east of Two Mile Run is composed almost entirely of the Catskill red rocks; the soil is red and there are occasional outcrops by the roadside. Not far east of Mr. Thomas Frost's house is a band of greenish-gray sandstone and reddish sandstone above it. The dip is between 24° and 26° N., 55° W. At the eighth mile post west of Frostburg the dip is 27° N., 55° W. and strike is N., 35° E. The base of the Catskill is toward the crest of the ridge and a dip of 22° N., 60° W. was noted. Small loose blocks of flat pebble conglomerate were picked up at this locality and some of them were broken across smoothly. On the summit of the ridge are greenish shales and sandstones which are in the Jennings although on the eastern side of the ridge, not far west of Mr. Wm. Michel's house, are zones of red shale a number of feet in thickness and the soil is reddish.

The limits of the Catskill are not sufficiently well defined to make possible any very accurate estimate of its thickness. Its horizontal outcrop, however, was called 1⅜ miles, the direction about 45° from the

true dip and the average of the several determinations of dip 23° which, after correcting and solving, gives a thickness of 2010 feet which being very near that of the formation indicates that about its true limits were taken.

The contact of the Jennings and Catskill formations is not shown on this eastern limb of the anticline on the National Road; but it is thought that the base of the Catskill formation is reached in the lower part of the western slope of the first ridge west of Mr. Thomas Johnson's house, about 4½ miles northwest of Frostburg. In the upper part of the ridge the rocks are mostly reddish shales and thin bedded sandstones with some thin bands of greenish shales and sandstones. The soil is colored as red as that produced by the Catskill formation. The dip varies from 20° to 22° to the east. On the eastern slope of the ridge directly above Mr. Johnson's the shales and sandstones are a much brighter red than the rocks in the upper part of the formation on the western slope of Little Savage Mountain. It is believed to be generally the case in western Maryland that the lower and middle parts of the formation are a brighter red than the upper portion. For some distance the rocks are mostly concealed but from the chapel on the western slope of Little Savage Mountain to its summit there are frequent outcrops of the upper part of the Catskill formation. Just above the chapel is a zone of greenish-gray, coarse grained, very micaceous sandstone succeeded by brownish-red rather coarse argillaceous shale. Then, after a covered interval, there is a zone of greenish-gray, micaceous sandstone and greenish shale; but it is much broken and hardly forms a ledge. Higher, are brownish-red, thin bedded sandstones capped by brownish-red arenaceous shales. Then there is another brownish-red, micaceous sandstone zone, massive and irregularly bedded with a dip of 22° S., 75° E. Following this are red to brownish-red, micaceous, arenaceous shales which run into thin bedded sandstones. Then, near the crest of the mountain, is a conspicuous zone of greenish-gray sandstone and greenish argillaceous shale having a dip of 25° with a horizontal distance of 270 feet, making it 113 feet in thickness. This, or a similar zone of greenish-gray rock has been noted in a number of sections near the top of the

Catskill formation. On the crest of Little Savage Mountain immediately succeeding in stratigraphic order the greenish zone just described is one of brownish-red, very micaceous sandstone in which some small openings have been made on each side of the road. It is a fairly heavy bedded sandstone but with a more or less cross-bedded structure. The average dip of these beds to the north of the road is about 25° S., 60° E.

On the south side of the road at the summit is a ledge of brownish-gray, very micaceous sandstone in which there is a small excavation. Some of the layers are brownish-red and others grayish and the surface of most of them is very irregular. The dip of these layers varies from 25° to 27° S., 55° E.; while in the road at the corner are dips varying from 24° to 28°. Just to the east of the crest and a few feet above the brownish-red, micaceous sandstone is a stratum of mottled, brownish-red and greenish sandstone. This is the highest stratum shown on the road which could be included in the Catskill. The thickness of this brownish-red and mottled zone at the top of the Catskill is 14 feet.

An estimate of the thickness of the Catskill of this section (No. I) was made by pacing the distance from a point near the foot of the first ridge west of Mr. Johnson's to the crest of Little Savage Mountain, in a direction about at right angles to the strike and averaging the various observed dips which gave a thickness of nearly 1900 feet.

Exposure on Road over Four Mile Ridge.—On the steep hillside, 1 mile south of Avilton, are interrupted outcrops of the lower part of the Catskill formation which consists largely of blocky brownish-red sandstone alternating with red shale; some of the lower sandstones are in thin layers and cross-bedded. The dip is between 18° and 19° S., 70° E. In the bed of Savage River thin bedded, brownish-red sandstones show a dip of 17°. In the lower part of Four Mile Ridge are conspicuous ledges of brownish-red sandstone, somewhat cross-bedded, alternating with red, rather blocky shales. This zone is well shown along the highway up the ridge and the dip varies from 18° to 20° eastward with a strike N. 35° E. There are various exposures of the red shales and sandstones farther up the road with dips varying from 20° to 24° and a strike of N. 35° E. The upper part of the Catskill formation is partly concealed;

but its top is reached near the summit of Four Mile Ridge on the road to Lonaconing. The horizontal distance, measured on the map, across the Savage River is but 1 mile between the top and bottom of the Catskill formation which on averaging the dip, would give a thickness of about 1700 feet for the formation. It is probable, however, that the horizontal distance is underestimated. The red shales and sandstones of the Catskill formation are also well shown to the southwest of the above locality on the road from Savage River up Warnick Run nearly to the top of Elbow Mountain.

At the western end of the Baltimore and Ohio Railroad cut just east of Altamont station are red shales and sandstones. A little farther east are greenish, coarse grained sandstones and shales in which a few imperfectly preserved pelecypods were found. The dip is between 16° and 17° S. E. This cut as shown on the Geological Map of the Piedmont Folio is near the top of the Catskill and it is apparently the zone of greenish rocks in the upper part of that formation. The occurrence here of a few very imperfectly preserved fossils becomes important. The lithological character of the rocks in the upper part of the Catskill shows that there was a somewhat gradual change from the conditions under which they were deposited to those of the Pocono.

The greater part of the Catskill is simply an alternation of red shales and sandstones with zones of greenish rock in the lower and upper part of the reds. The Chemung fauna survived for some time after the conditions were such that thick masses of brownish-red to red rocks were being deposited, but most of the fossils are found in zones of rock which in lithological characters more closely resemble those of the ordinary Chemung than the Catskill. It is possible that other localities of the greenish rocks in the upper Catskill will furnish fossils and these will probably be confined to those forms capable of life under very adverse conditions as for example the comparatively few species of pelecypods and fishes which have been found in the Oneonta and Catskill formations of New York and Pennsylvania.

CORRELATION OF THE UPPER DEVONIAN[1]

The Upper Devonian strata of Maryland consists of two types of sediments, a lower marine type termed the Jennings formation, and an upper continental type called the Catskill formation. These formations will be considered in the order of their deposition.

THE JENNINGS FORMATION

INTRODUCTORY

Nature of the Problem.—The Jennings formation consists of interbedded shales and sandstones 4000 to 4800 feet thick in Maryland, the study of which presents great difficulties. This is due in part to the great variability in the composition of the sediments. Sandstones and shales succeed each other at frequent intervals in vertical sequence, while beds of sandstone that appear very massive at one locality may pass into a series of sandstones and shales in a short distance on the strike and these again into shales, or *vice versa,* rendering it very difficult to discover persistent horizons in them. Although fossils are profuse in some strata they are rare in others, wide intervals being nearly barren, necessitating a careful search for the fossiliferous horizons. Finally, the beds are intricately folded in the Appalachian structure, while the areas in which the Jennings outcrops, are separated by others in which the strata have been removed by erosion. These features, in addition to the problems presented by the contained faunas, unite to render the study of this formation most difficult.

Method of Solution.—The foregoing facts have rendered it necessary to make a detailed study of the sections of the Jennings throughout the State.[2] The method has been to investigate the sections exposed in each of the detached areas of Jennings in Maryland and in adjoining

[1] Contributed by Charles K. Swartz.

[2] Professor Prosser, who studied the Upper Devonian before the investigations of the writer were undertaken, describes a number of these sections elsewhere in this volume. The author is greatly indebted to him for the privilege of examining his results in advance of their publication.

parts of Pennsylvania and West Virginia, in order to establish a series of persistent lithological and faunal horizons, and then to correlate the divisions so established with the strata of other regions. The subject will be discussed under the headings: Lithological and faunal subdivisions, Correlation.

LITHOLOGICAL AND FAUNAL SUBDIVISIONS

An examination of the local sections shows that the Jennings formation of Maryland is divisible into four members which are distinct both lithologically and faunally. The members are further subdivided into a number of lithological divisions, and faunal zones as shown in the following table:

JENNINGS FORMATION.
- *Chemung sandstone member.* Spirifer disjunctus fauna.
  - Upper sandstone and shale. Camarotœchia eximia zone. In the central part of the area these beds comprise three divisions.
    - Beds of recurrent Jennings type with a marine fauna. Palæanatina angusta zone.
    - Red beds of Catskill type.
    - Beds of Jennings type with a marine fauna.
  - Upper Chemung conglomerate.
  - Middle sandstone and shales.
  - Lower Chemung conglomerate, Tropidoleptus carinatus zone.
  - Lower sandstone and shale, Dalmanella tioga zone in west.
- *Parkhead sandstone member.* Recurrent Tropidoleptus carinatus fauna.
  - Shale beds.
  - Conglomeratic sandstone beds.
    - Cyclonemina multistriata zone.
    - Camarotœchia congregata var. parkheadensis zone.
    - Liorhynchus mesacostale zone.
- *Woodmont shale member.*
  - Beds containing Ithaca fauna. (Spirifer mucronatus var. posterus fauna).
    - Liorhynchus globuliforme zone.
    - Cladochonus-Reticularia lævis zone.
  - Beds containing the Naples fauna (Buchiola speciosa fauna).
- *Genesee black shale member.*

Genesee Black Shale Member

CHARACTER AND THICKNESS.—The Genesee member consists of fissile, black, argillaceous shale, characterized by breaking into large flat sheets

which weather into thin fragile flakes with parallel sides. The shale is quite carbonaceous and becomes chocolate brown upon prolonged weathering. Many exposures of considerable thickness exhibit a system of well-developed joints, which intersect nearly at right angles to the bedding, a feature frequently seen in the Genesee formation of New York.

This member is 90 to 100 feet thick west of Wills Mountain. It diminishes in thickness and finally disappears eastward, the most easterly exposure observed being on the flanks of the anticline forming Strafford Ridge, east of Oldtown.

FAUNA.—The Genesee shales abound in individuals of a few species. The fossils are chiefly minute pelecypods associated with pteropods and goniatites. The following species occur in this member according to the identifications of Dr. J. M. Clarke: *Buchiola retrostriata, Buchiola conversa, Buchiola livoniæ, Pterochænia fragilis, Lunulicardium encrinitum Styliolina fissurella, Pharetrella tenebrosa, Tornoceras uniangulare, Probeloceras lutheri, Bactrites aciculus, Orthoceras filosum.*

ROMNEY-GENESEE BOUNDARY.—The boundary between the Genesee and Romney is well defined both lithologically and topographically. A massive sandstone occurs either at, or a short distance below the top of the Romney, while the shale of the upper part of that formation breaks into fragments of very irregular shape which weather to a yellowish or greenish color, contrasting sharply with the smooth fissile brown, or black platy fragments of the Genesee. The Genesee usually occupies a valley developed between the upper sandstone of the Romney and the hard resistant olive-green shale of the Woodmont shale member.

Woodmont Shale Member

CHARACTER AND THICKNESS.—The Woodmont shale member receives its name from Woodmont Station, Washington County, ½ mile east of which it is well exposed in the cut of the Western Maryland Railroad. This station is situated about ¾ of a mile west of Tonoloway Ridge which is opposite Great Cacapon, West Virginia. It is also finely exposed at many places on the banks of Town Creek. It overlies the Genesee shale member conformably or in the absence of the latter, the Romney

formation. It consists of alternating courses of olive-green shale and thin, fine-grained, flaggy sandstone, with an occasional more massive sandstone. The shale is usually fissile and breaks into smooth thin fragments with parallel sides, contrasting strongly in this respect with the very irregular fragments produced by the weathering of the underlying Romney. Some of the upper beds are more arenaceous and fracture irregularly. Upon weathering the shale becomes greenish or yellowish. A few beds have a decided reddish-brown color. The sandstone is prevailingly micaceous and usually becomes fissile upon weathering, breaking into platy fragments. Occasionally a sandstone is more massive and breaks into larger, irregular fragments. The surface of the shale often exhibits "dimpling" and indistinct wave markings.

The strata of this member usually occupy the lower slopes of the ridges formed by the more resistant sandstone of the Parkhead member.

The thickness varies from 1600 feet in the eastern sections to 1200 or 1300 feet in the sections west of Green Ridge.

Subdivisions.—The Woodmont member consists of two divisions, the beds containing the Naples fauna and the beds containing the Ithaca fauna.

Beds Containing the Naples Fauna.—The beds containing the Naples fauna form the lower division of the Woodmont member. They consist of olive-green, hard, fissile, argillaceous shale, alternating with numerous courses of thin, fine-grained, flaggy sandstones. The lower beds are often largely formed of olive-green shale.

The thickness varies from 500 to 600 feet in the eastern sections, to 1200 to 1300 feet west of Green Ridge.

These beds contain a fauna which resembles, in many respects, that of the Genesee member. The species are chiefly small, delicate-shelled pelecypods and goniatites. Fossils are more abundant in the lower strata, though many beds are nearly barren.

The following species occur in this division according to the identifications of Dr. J. M. Clarke: *Buchiola retrostriata, Pterochænia fragilis, Tornoceras uniangulare, Bactrites aciculus.*

Beds Containing the Ithaca Fauna.—The beds containing the Ithaca fauna so closely resemble those of the underlying division lithologically, that it has not proven practicable to separate them upon the map of the region. In general the shale tends to be somewhat softer than that of the lower division and some beds break with a more irregular fracture, while the proportion of sandstone is somewhat smaller. In a single section in Thompson Township, Fulton County, Pennsylvania, in the extreme northeastern part of the area studied, the upper limit of the Woodmont member has been so drawn as to include several conglomeratic sandstones. No conglomerates have been observed in this member west of that point.

East of Sideling Hill the top of the division is frequently formed by a bright red bed which, in its lithological features, closely resembles sediments of the Catskill formation. Some of the lower beds have also a reddish tone.

The Ithaca fauna ranges through a thickness of 1000 to 1100 feet in the vicinity of Hancock. Farther west the fauna becomes more restricted and finally vanishes west of Green Ridge where it is replaced by the Naples fauna in the same strata that contained the Ithaca fauna farther east.

The Ithaca fauna differs greatly from that contained in the underlying beds. Brachiopods occur in profusion, while many large pelecypods of entirely different genera from those found in the Naples fauna are present. A list of the species observed in these beds is given in the table of distribution.

The beds containing the Ithaca fauna may be subdivided into two faunal zones, a lower termed the *Cladochonus-Reticularia lævis zone* and an upper, the *Liorhynchus globuliforme zone.*

GENESEE-WOODMONT BOUNDARY.—When the Genesee is present the lower limit of the Woodmont member is defined by the contrast between the olive-green color of the Woodmont shale and the black or brown color of the Genesee shale. The transition from the Genesee to the Woodmont is, however, not very abrupt, so that the precise plane of division is not always determinable, some of the beds being more or less transitional at many places.

In the absence of the Genesee, the Woodmont is readily discriminated from the underlying Romney by the marked difference in the shape of the fragments produced by weathering, the Romney yielding pieces of very irregular shape, while the Woodmont yields smooth thin plates whose two larger surfaces are nearly parallel. The abundance of brachiopods in the Romney and their almost entire absence from the lower beds of the Woodmont member is another decisive difference.

Parkhead Sandstone Member

CHARACTER AND THICKNESS.—The Parkhead sandstone member receives its name from Parkhead, Washington County, Maryland, a station on the Western Maryland Railroad, 7 miles east of Hancock, where its strata are well exposed. It consists of shale interbedded with massive, frequently conglomeratic sandstones. Certain beds of the latter are highly fossiliferous at many places. The shale is more arenaceous than that of the Woodmont member and tends to break more irregularly. When freshly exposed the strata vary in color from gray to olive-green, while some beds are nearly black. Upon weathering they usually become yellowish or buff in color. The thickness varies from 400 feet in the eastern exposures to 800 feet west of Green Ridge.

FAUNA.—The fauna of the Parkhead member has strongly pronounced affinities with the Hamilton fauna. Among the more diagnostic species found in it are *Tropidoleptus carinatus, Camarotœchia congregata* var. *parkheadensis* and *Spirifer* (*Delthyris*) *mesacostalis,* while *S. marcyi* var. *superstes* and *Rhipidomella vanuxemi,* etc., are also abundant in the more westerly sections.

Three faunal zones may be distinguished in this division. These are, in ascending order: The *Liorhynchus mesacostale zone,* the *Camarotœchia congregata zone* and the *Cyclonemina multistriata zone.*

The *Liorhynchus mesacostale zone* is chiefly developed in the western sections. It is found at the base of the member in somewhat shaly beds that lie below the more massive sandstones. Among the more diagnostic species are *Liorhynchus mesacostale, Leptodesma naviforme,* and several species of the genus *Lingula.* The *Camarotœchia congregata zone* is char-

acterized by a very profuse development of *Camarotœchia congregata* var. *parkheadensis, Tropidoleptus carinatus,* and *Spirifer* (*Delthyris*) *mesacostalis.* The *Cyclonemina multistriata zone* contains a great profusion of fossils of many genera, including many gastropods. The range of the species observed in these zones is shown in the chart of columnar sections. (See pocket in cover.)

SUBDIVISIONS.—The Parkhead sandstone member is divisible into two parts, a lower containing conglomeratic sandstones and an upper consisting more largely of shale.

Conglomeratic Sandstone Beds.—This division constitutes the larger part of the Parkhead member. It usually contains conglomeratic sandstones at three horizons in the eastern part of the area—at its base, near its middle and at its top respectively. The sandstones are not argillaceous, as are many in the Woodmont member. They are often bluish black when fresh, becoming buff colored upon weathering and, in places, are tinged yellow and red by iron. They usually break into large irregular pieces.

The lower sandstone is, as a rule, highly fossiliferous, abounding in *Camarotœchia congregata* var. *parkheadensis* and containing also a profusion of *Tropidoleptus carinatus* at many places. The upper conglomeratic sandstone is unusually massive near Parkhead, where it is finely exposed in the cut of the Western Maryland Railroad, west of the station. The Parkhead member usually forms a pronounced ridge, the crest of which is commonly occupied by the middle conglomerate.

The beds of sandstone lose their conglomeratic character and become reduced in volume toward the west. West of Wills Mountain they are largely replaced by shales so that this member can scarcely be distinguished from the underlying Woodmont in that region.

The sandstone division is about 400 feet thick in the eastern sections. Its limits are less clearly defined west of Washington County.

The upper part of the Parkhead member consists largely of shale with some interbedded sandstone. It contains few fossils to indicate its relations. It lies, however, below the horizon at which the first appearance of the Spirifer disjunctus fauna has been observed. The shale beds have been

FIG. 1.—VIEW SHOWING THE CATSKILL FORMATION ON JENNINGS RUN ROAD 1 MILE EAST OF BARRELVILLE.

FIG. 2.—VIEW SHOWING THE LOWER PART OF THE CATSKILL FORMATION ON JENNINGS RUN.

included in the Chemung on the geological map of Washington County, because of the ease of drawing the base of the Chemung at the top of the upper Parkhead conglomerate, elsewhere they have been included in the Parkhead member.

The thickness of this division varies from 300 to 400 feet.

WOODMONT-PARKHEAD BOUNDARY.—The boundary between the Woodmont and Parkhead members is usually rather distinct, though at places it is very difficult to determine its exact position. Massive sandstones usually develop at the base of the Parkhead, which are conglomeratic in the eastern sections, although thick sandstones may also occur in some places in the upper part of the Woodmont member. The lower sandstones of the Parkhead can be distinguished at many localities by being bluish-black when freshly exposed. Upon weathering they become buff-colored and break into large, irregularly shaped pieces, in contrast with the Woodmont sandstones which usually break into flat platy pieces, due to the presence of clay. The shale of the Parkhead is, as a whole, more arenaceous and tends to break more irregularly than the Woodmont shale. At many places in Washington County a bright red band forms the top of the Woodmont member. The distinctive feature, however, is the occurrence of a great profusion of fossils in the basal sandstones of the Parkhead, among the most abundant species being *Camarotœchia congregata* var. *parkheadensis, Tropidoleptus carinatus, Spirifer (Delthyris) mesacostalis* and, in the western sections, *Spirifer marcyi* var. *superstes.* At places these fossils are so abundant as to render the rock almost a coquina.

The lowest fossiliferous beds of the Parkhead are usually found on the slope of the ridge facing the subjacent strata.

Chemung Sandstone Member

CHARACTER AND THICKNESS.—The Chemung sandstone member overlies the Parkhead member with which it is so intimately connected by transitional beds as to render their discrimination difficult. It consists of alternating shale sandstone and conglomerates, the percentage of sandstone generally increasing toward the top of the formation. The shale

is usually more arenaceous than that of the underlying members and hence breaks more frequently into irregular pieces, while the sandstone is not argillaceous and is rarely fissile. The beds are variously colored, gray, olive-green, yellow, and brown being common tints. Upon weathering many beds become yellowish or brown and are often stained by iron. Red or brownish-red beds are of frequent occurrence, the percentage of red strata increasing toward the top of the member. These beds occur at successively lower and lower horizons toward the east until in the sections east of Millstone, they appear near the base of the member.

Conglomerates occur at many horizons in the Chemung clearly indicating its littoral character. A comparison of the different sections shows that there are two more persistent zones of conglomerates east of Wills Mountain although it must be noted that other conglomerates are present, and may readily be confused with them. These conglomerates are not single beds but zones of massive sandstones some of which are usually conglomeratic. They are recognizable topographically by the fact that the upper zone tends to form the crest of a high ridge, when at a distance from larger streams, while the lower zone tends to form a minor ridge on the flanks of the larger. In the more easterly sections the Catskill strata descend so close to the upper conglomerate as to obscure these relations. Again, the lower conglomerate may be the stronger ridge-maker locally.

The thickness of this member varies from 2000 to 2300 feet.

FAUNA.—The Chemung member contains a distinct fauna, the most characteristic species of which is *Spirifer disjunctus*. Associated with the latter and scarcely less diagnostic, are various species of the genera *Dalmanella* and *Douvillina*. The latter are, however, more restricted in geographical distribution and vertical range. Many other species cited in the table of distribution are also restricted to this member, but are more limited in range and distribution and hence less important for purposes of correlation.

SUBDIVISIONS.—The upper and lower conglomerates divide the Chemung member into five parts, which are here termed the lower shale and sandstone beds, the lower conglomerate, the middle shale and sandstone

beds, the upper conglomerate, and the upper shale and sandstone beds respectively. The upper beds are in turn subdivided into three parts. The following table indicates the sequence and faunal zones west of Sideling Hill.

Chemung member.
- **Upper shale and sandstone beds. Camarotœchia eximia zone.**
  - **Beds of Jennings type. Palæanatina angusta zone.**
  - **Red beds of Catskill type.**
  - **Beds of Jennings type.**
- **Upper conglomeratic sandstone beds.**
- **Middle shale and sandstone beds.**
- **Lower conglomeratic sandstone beds. Tropidoleptus carinatus zone.**
- **Lower shale and sandstone beds. Dalmanella tioga zone west of Wills Mountain.**

A third persistent conglomerate occurs between the lower and upper conglomerates in the sections west of Wills Mountain, whose relation to the conglomerates of the eastern section is not apparent. The characteristics of these divisions will now be briefly considered.

Lower shale and sandstone beds, Dalmanella tioga zone west of Wills Mountain. These beds consist of shale and interbedded massive sandstones. In the syncline west of Warrior Mountain many of the strata are very red, suggesting the red bed that occurs in a similar position in the section on Williams Road, Polish Mountain. East of Wills Mountain, the beds of this division contain a number of species that pass up into them from the Parkhead member, among which gastropods are very prominent. (See table of distribution.) West of Wills Mountain the lower beds are characterized by a profuse development of *Dalmanella tioga,* which species has not as yet been observed in Maryland either at higher horizons or east of Wills Mountain.

Lower Conglomeratic Sandstone Beds.—Tropidoleptus carinatus Zone. A massive conglomeratic sandstone appears in most of the sections east of Wills Mountain about 600 feet above the base of the Chemung member, which probably represents one horizon. This is shown by the fact that it contains a recurrence of the Tropidoleptus carinatus fauna and also by its nearly constant altitude (600 feet) above the base of the Chemung. The conglomerate contains flat pebbles often of a large size, some of

which are jasper. A similar massive sandstone, containing the Tropidoleptus carinatus fauna, occurs about 300 feet above the base of the Chemung west of Wills Mountain. While it may represent the same horizon, it is not possible to affirm this confidently, because of the differences in the sections east and west of Wills Mountain.

Among the most important species occurring in these beds are *Tropidoleptus carinatus, Spirifer morcyi* var. *superstes, Rhipidomella vanuxemi* and other species of Hamilton affinities, a complete list[1] of which is given in the table of distribution. The recurrence of a fauna of pronounced Hamilton affinities above the base of the Chemung is of much interest.

Middle Shale and Sandstone Beds.—The preceding division is overlain by shales and interbedded sandstones. West of Wills Mountain a very massive gray and brown conglomeratic sandstone occurs between the upper and lower conglomerates. It is not improbable that it is in the middle of this division, though its relation is not assured. A list of the species observed in this division is given in the table of distribution. No distinctive features have been recognized in this fauna.

Upper Conglomeratic Sandstone Beds.—A zone of massive conglomeratic sandstones occurs in the sections east of Wills Mountain, about 800 feet above the lower conglomerate. No distinctive fauna has been observed in it, but the constancy with which the conglomerates appear at about the same horizon, and the fact that they are always very massive and ridge-forming, leads to the conclusion that they probably constitute one horizon. West of Wills Mountain a similar, very massive, ridge-forming conglomerate occurs 500 to 800 feet below the top of the Jennings and probably represents the same horizon.

The upper conglomerate contains flat quartz pebbles, which are often large. Some jasper pebbles are also found in it. The cement is so firm that the rock usually breaks across the pebbles the fractured faces of which present a polished appearance. An attempt has been made to dis-

[1] In the Woodmont section the Tropidoleptus fauna occurs 54 feet above what appears to be the lower conglomerate. Whether the fauna is higher than usual or the conglomerate is at a lower horizon in that section is not known.

tinguish the upper conglomerate by the lithological features named. The distinction does not appear to be assured, however, since the lower conglomerate contains similar flat pebbles, some of which are also jasper.

Upper Shale and Sandstone Beds. Camarotœchia eximia Zone.—East of the Oakland anticline many of the strata of this division contain much iron hydrate and are discolored by iron stains. Associated with this feature are distinct faunal peculiarities. The fossils are often small and depauperate, while species of restricted range appear. This may be called the *Camarotœchia eximia zone* from the profuse occurrence of that species in it.

Red beds occur in the midst of this division in the region west of Sideling Hill dividing it into three parts as given in the preceding table.

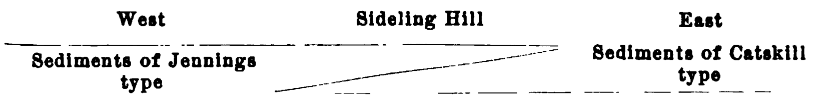
In the Oakland anticline the conditions seem quite different, little ferruginous material being present in these beds, while they are highly fossiliferous and the species are not depauperate. The stratigraphy of that region has, however, not been worked out in detail because of the imperfect character of the exposures.

CHEMUNG-PARKHEAD BOUNDARY.—It is very difficult to determine this boundary with precision, owing to the close lithological resemblance of these members. The base of the Chemung is generally marked lithologically by a distinct increase in the percentage of sandstone, the lower beds of the Chemung usually containing heavy sandstones although this feature is not constant. In some localities red strata appear a little above this horizon. In Washington County the base of the Chemung was drawn, for convenience in mapping, at the top of the upper conglomerate of the Parkhead member. The only assured criterion for the separation of the Chemung and Parkhead is the incoming with the Chemung of the Spirifer disjunctus fauna, the most distinctive members of which are *Spirifer disjunctus* and species of the genera *Douvillina* and *Dalmanella.*

Catskill-Chemung Boundary.

Barren red sediments of Catskill type alternate with lighter-colored, fossiliferous sediments of Jennings type in the upper part of the Jennings. Such alternations become quite frequent toward the upper limit of the

formation, often rendering it very difficult to fix upon a precise boundary between the Jennings and Catskill. In the area west of Sideling Hill a thick red bed which resembles Catskill sediments in all respects, makes its appearance about 4000 feet above the base of the Jennings, and is in turn overlain by deposits of Jennings type carrying Chemung fossils. Persistent Catskill sediments reappear 4700 to 4800 feet above the base of the Jennings. Eastward the Catskill thickens and the red strata appear lower and lower in the section. The relations believed to exist are illustrated in the following diagram:



In view of the foregoing facts the question arises, What is the upper limit of the Jennings formation? It is well known that the Chemung and Catskill are not successive formations but are, to a considerable extent, of the same age, representing two phases of sediments deposited at the same time but under different conditions, the Catskill phase accumulating more largely in the east, while the Chemung phase has its larger development farther west. It is hence impossible to discriminate them upon the basis of age. It is manifest that Catskill and Jennings conditions alternated in the same region, due probably to oscillations of level, so that sediments of Jennings and Catskill type intertongue repeatedly, the Catskill beds thickening eastward and the Chemung beds thickening westward.

The line of division between the Catskill and Chemung is hence arbitrary to a large degree and expresses the opinion of the observer. The method used in discriminating these formations in Maryland has been to draw the top of the Chemung at the upper limit of abundant marine fossils, which is also in general at the base of the more persistent red beds. This is the most trustworthy and hence the most satisfactory method to employ in this area, in the opinion of the writer, since the highest marine fauna is of undoubted Chemung type.

CORRELATION WITH NEW YORK

The Upper Devonian of this country was first studied with care in the state of New York, from which area many of the formational names were derived. Continued investigation has rendered our knowledge of the Devonian of that state more accurate and detailed than that of any other region in America. The correlation of the Jennings with the Upper Devonian of New York will therefore be considered first and after this its relation to corresponding strata in Pennsylvania. The correlation with the Upper Devonian of West Virginia is considered in the discussion of the local sections.

The Jennings formation is intimately related to the marine Upper Devonian of New York. This will be seen best by considering the correlation of the various members of the Jennings with the corresponding strata of New York.

GENESEE SHALE MEMBER.—A list of species that occur in the Genesee shale member has been given on a preceding page. Among the most abundant forms are: *Buchiola retrostriata, Pterochænia fragilis, Styliolina fissurella,* and various goniatites. Two of the species are new. All of the remainder are found in the Genesee of New York in which *Styliolina fissurella, Pterochænia fragilis* and species of *Buchiola* are abundant.

The strata of this member are similar lithologically to those of the Genesee of New York, both being black, carbonaceous shales, while they occupy a like stratigraphic position. Both also attain their maximum thickness in the west and become thinner and disappear eastwards.

The close resemblance of these strata in fauna, lithology, stratigraphic position, and geographic distribution, fully justifies their correlation with the Genesee formation of New York as has been published by Prosser.

WOODMONT SHALE MEMBER.—The Woodmont shale member has been shown to consist of two divisions. The lower of these contains the Naples fauna and is equivalent to the Sherburne of New York. The upper contains the Ithaca fauna and is equivalent to the Ithaca of that state.

These divisions are paleontological in the Maryland region and are mapped as a unit, since they have not been differentiated lithologically. It is not improbable, however, that they may be discriminated in the future when the names Sherburne and Ithaca would be appropriate because of their close resemblance to those members of the Portage formation of New York.

Beds Containing the Naples Fauna.—A list of the species observed in this zone in Maryland has been given on a preceding page. All are characteristic of the Naples fauna which occurs in the Sherburne member of the Portage of New York. Fossils are rare in these beds in both areas.

The Maryland strata also resemble the Sherburne beds lithologically, consisting of alternating fissile, olive-green shale and flaggy sandstones, while they occupy a like stratigraphic position in both states. The vertical range of the faunas is similar in both sections. The resemblance of this division to the Sherburne of New York is thus so close as to indicate their essential identity.

Beds Containing the Ithaca Fauna.—The upper division of the Woodmont member closely resembles the underlying strata lithologically, but contains a very distinct fauna characterized at most localities by the abundant occurrence of *Spirifer mucronatus* var. *posterus, Productella speciosa, Pugnax pugnus* var. *altus, Schizophoria striatula, Cyrtina hamiltonensis,* and *Liorhynchus globuliforme.* The table of distribution lists the species observed in this zone in Maryland and gives their occurrence elsewhere.

Seven of these species, *Spirifer mucronatus* var. *posterus, Productella speciosa, Cyrtina hamiltonensis, Atrypa reticularis, Spirifer mesistrialis, Actinopteria* cf. *boydi,* and *Palæoneilo constricta* are placed by Williams among the dominant species of the Ithaca fauna.[1] *Pugnax pugnus* var. *altus* and *Schizophoria striatula* are also prominent members of that fauna. One of the species, *Pterinea chemungensis,* is said by Williams[2]

[1] Bull. U. S. Geol. Survey, No. 210, p. 74, 1903.

[2] Journal of Geology, vol. xv, p. 98, 1907.

to be characteristic of the Chemung in New York. Clarke,[1] however, cites it from the Ithaca of New York, while Williams and Kindle[2] identify it in the Ithaca fauna at Catawissa, Pennsylvania. Its occurrence below the range of the Chemung fauna in Maryland is well established. *Liorhynchus globuliforme* is assigned by Williams[3] to a higher horizon in New York, but is quoted from the Ithaca fauna of east-central New York, by Clarke.[4] The fauna includes thirty species, of which three are new. Of the previously described forms, twenty-two or 73 per cent, occur in the Ithaca fauna of New York or Pennsylvania. Four not found in the Ithaca fauna of those states occur in the Hamilton of New York, while but one species, *Grammysia communis,* has not been hitherto reported in horizons below the Chemung. Thus all but one of the previously described species are found in the Hamilton or Ithaca of New York or Pennsylvania. These facts fully justify the correlation of this fauna with the Ithaca fauna of New York.

It has already been shown that the Ithaca fauna of Maryland possesses a considerable vertical range in the eastern sections but becomes more restricted and finally vanishes in the west, where it is replaced by the Naples fauna. In this respect it also resembles the Ithaca fauna of New York. The beds containing this fauna consist more largely of shales than do the underlying strata in either Maryland or in New York.

Cladochonus-Reticularia lævis Zone.—The lower zone of the Ithaca of Maryland has been designated the *Cladochonus-Reticularia lævis zone* from its most characteristic species, *Cladochonus humilis* and *Reticularia lævis.* All the species of the zone, save two new species, occur in the Ithaca of New York and nearly all in central New York. A species of Cladochonus, which is not improbably the same as one found in Maryland, is common in the lower portion of the Ithaca beds at Ithaca, New York. *Reticularia lævis* occurs at two horizons at Ithaca, one near the base and

[1] Bull. N. Y. State Museum, No. 82, p. 62, 1905.
[2] Bull. U. S. Geol. Survey, No. 244, p. 77, 1905.
[3] Folio No. 169, U. S. Geol. Survey, p. 6, 1909.
[4] Ithaca fauna of Central New York, Bull. N. Y. State Museum, No. 82, p. 64, 1905.

one near the top of the Ithaca beds. This zone may correspond to the beds containing the Ithaca fauna in central New York. It does not seem possible to correlate these horizons precisely at present, although the occurrence of these species in Maryland is of interest.

Liorhynchus globuliforme Zone.—H. S. Williams has described a fauna from east-central New York to which he has applied the name Liorhynchus globuliforme fauna from the abundant development of that species in it. He says that "the Ithaca fauna as a whole may be called the *Spirifer pennatus* var. *posterus* fauna which on passing eastward is separated into three distinctive paleontological zones, the H^2 *Paracyclas lirata zone,* H^3 *Spirifer mesastrialis zone,* H^4 *Liorhynchus globuliforme zone.*"[1] He further states that the latter zone occupies a higher stratigraphic position than does the Ithaca fauna of central New York, correlating the beds containing it with the basal strata of the Enfield member of the Portage of New York. He thus manifestly regards the Liorhynchus globuliforme fauna as a later phase of the Ithaca fauna which is restricted to east-central New York. Many characteristic species of the Ithaca fauna of central New York are present in it including *Spirifer mucronatus* var. *posterus, Pugnax pugnus* var. *altus, Schizophoria striatula, Productella speciosa, Cyrtina hamiltonensis, Stropheodonta demissa,* and *Leptostrophia interstrialis.* It contains, however, *Spirifer (Delthyris) mesacostalis* which makes its first appearance in the Ithaca region in the Tropidoleptus fauna overlying the Ithaca beds.

The Liorhynchus globuliforme fauna of Maryland occupies the upper part of the Ithaca beds and bears a marked resemblance to the fauna of the same name in New York as shown by its stratigraphic position and by its dominant species and is probably to be correlated with that fauna; but differs, both in its purer Ithacan character, and in lying below the zone of *Spirifer (Delthyris) mesacostalis.* The latter species makes its first appearance in the overlying Tropidoleptus carinatus fauna in Maryland, as it does in central New York. These facts suggest that the Liorhynchus globuliforme fauna of Maryland may occupy a somewhat lower stratigraphic position in Maryland than in east-central New York.

[1] Folio 169, U. S. Geol. Survey, 1909, p. 6.

The fauna of this zone also bears some resemblance to that found in the higher beds containing the Ithaca fauna at Catawissa, Pennsylvania.[1] This is shown by the presence of *Pterinea chemungensis* and *Ectenodesma birostratum* at both localities. The latter species is confined to the *Liorhynchus globuliforme zone* in Maryland.

Although many species of the Ithaca fauna occur in the Hamilton formation, it is interesting to note that it contains many forms of different origin, including some of its more important members. Among these are *Spirifer mesastrialis, Productella speciosa, Liorhynchus globuliforme, Pugnax pugnus* var. *altus,* and *Schizophoria striatula.* While there are Hamilton elements in the fauna, it cannot properly be called a recurrent Hamilton fauna in a strict sense and differs greatly from the assemblage next to be described.

PARKHEAD SANDSTONE MEMBER.—Among the most important and characteristic species of this member are: *Tropidoleptus carinatus, Spirifer (Delthyris) mesacostalis, S. marcyi* var. *superstes, Camarotœchia congregata* var. *parkheadensis, Rhipidomella vanuxemi, Cyrtina hamiltonensis, Cypricardella bellistriata, Liopteria bigsbyi, Coleolus tenuicinctus, Cyclonemina multistriata,* and *Pleurotomaria capillaria,* all of which occur in the Hamilton, save *Cyclonemina multistriata,* a new species. One of the most abundant species is *Tropidoleptus carinatus,* which is the most characteristic member of the Hamilton fauna, according to Williams, who terms that fauna the Tropidoleptus carinatus fauna.[2]

An examination of the table of distribution, in which all the species of this member are listed, shows that the entire assemblage possesses a pronounced Hamilton aspect, about 66 per cent of its species occurring in the Hamilton formation of New York. That it is, however, later than the Hamilton is shown by the modification of some of the species, as, for example, *Spirifer marcyi,* which is present as a mutation, and also by the presence of a considerable number of species of later age. The fauna is manifestly a recurrent Hamilton fauna with an addition of later species.

[1] Kindle and Williams. Bull. U. S. Geol. Survey, No. 244, p. 77, 1905.
[2] Bull. U. S. Geol. Survey, No. 210, 1903, p. 50.

A similar recurrence of fauna characterized by the *Tropidoleptus carinatus* overlies the *Liorhynchus globuliforme zone* in New York, where, according to Williams,[1] it contains *Tropidoleptus carinatus, Spirifer marcyi, Spirifer (Delthyris) mesacostalis, Productella lachrymosa, Rhipidomella vanuxemi, Cypricardella bellistriata, Pleurotomaria capillaria,* and other species found in the Parkhead fauna of Maryland. The recurrence of similar faunas in the same relative position in New York and Maryland is a most interesting fact and furnishes striking evidence of the essential similarity of the conditions in New York and Maryland in Upper Devonian time.

The Parkhead fauna, like that of the Enfield member of the Portage of New York, occurs in sediments that become increasingly arenaceous eastward, where they are similar to the Chemung sediments. The fauna vanishes westward in both areas. The similarity in composition, lithology, stratigraphic sequence, and geographic distribution leaves little doubt that the Parkhead fauna is the same as the recurrent Tropidoleptus carinatus fauna of the Enfield member of Williams. In the Enfield member, however, the Naples fauna recurs above the Tropidoleptus carinatus fauna, a feature not observed in the Parkhead of Maryland, so that the upper limits of the two members may not be the same. For the present, therefore, the term Parkhead is applied to this member instead of Enfield, although the beds containing the recurrent Tropidoleptus carinatus fauna are probably of the same age in both areas.

CHEMUNG MEMBER.—Different values have been attached to the term Chemung by different observers, rendering necessary a definition of its significance as here employed. The marine Upper Devonian strata lying above the Genesee, exhibit different facies in eastern and western New York. In the western part of that state the lower strata consist of interbedded shale and flaggy sandstones and contain very few brachiopods. They are overlain by more arenaceous sediments rich in brachiopods. Farther east sandstones develop at successively lower and lower horizons

[1] Folio No. 169, U. S. Geol. Survey, 1909, p. 6.

while many brachiopods appear both within and below them. Vanuxem[1] drew the base of the Chemung at the base of the more arenaceous sediments and called the brachiopod-rich horizon below the Chemung the Ithaca, while the brachiopod-poor shale beneath the Ithaca was named the Portage or Nunda. Hall[2] drew the base of the Chemung of central New York at the base of the brachiopod-rich fauna including Vanuxem's Ithaca and Chemung in his Chemung, as shown by his use of that term in the systematic volumes of the Paleontology of New York.

It was later shown by Williams[3] that the Naples fauna recurs above the Ithaca, a result which led to the separation of the Ithaca from the Chemung and its inclusion in the Portage group. Williams later[4] defined the Chemung formation as the strata through which the Spirifer disjunctus fauna prevails.

In 1897 Clarke[5] showed that the Chemung fauna makes its first appearance in the Genesee River section, above the Wiscoy shale which overlies the Portage (Nunda) sandstone, while in the Naples section, further east, it appears at a lower horizon, being found in the Portage sandstone. In 1905[6] Clarke accordingly proposed to restrict the term Chemung to strata of the age of those bearing the Chemung fauna at the type locality and which lie above the horizon of the Wiscoy (Prattsburg) shale, excluding the latter from the Chemung.

Williams[7] has since proposed to employ the term Chemung in a dual sense, calling the sediments containing the Spirifer disjunctus fauna, "the faunal Chemung" and the arenaceous sediments of which it is a part, "the lithological Chemung."

The usage of the various authors, as applied to these sediments in central New York, except that of Clarke, is shown approximately in the fol-

[1] Geology Third District, Geology of New York, p. 179, 1842.

[2] Palæontology of New York, vols. iv, v, vii. Refers Ithaca fossils to Chemung.

[3] Bull. U. S. Geol. Survey, No. 3, 1884, p. 20, also Bull. No. 41, 1887, pp. 81-82.

[4] Bull. U. S. Geol. Survey, No. 210, 1903, p. 82.

[5] Rep. N. Y. State Geologist for 1896, p. 33, 1899.

[6] Bull. N. Y. State Museum, No. 81, 1905, p. 20.

[7] Folio U. S. Geol. Survey, No. 169, 1909, p. 12.

lowing table. Clarke's section is from the Watkins-Elmira quadrangles in which the sequence of the beds below the Chemung differs from that in central New York.

Divisions	Hall	Vanuxem	Williams 1907[1]		Williams 1909		Clarke[2]
Beds containing the Spirifer disjunctus fauna	Chemung	Chemung	Chemung		Chemung Faunal Lithological		Chemung
Beds containing the Naples and Tropidoleptus carinatus fauna				Enfield		Enfield	Prattsburg
Beds containing the Ithaca fauna		Ithaca	Nunda	Ithaca	Portage	Ithaca	Senecan
Beds containing the Naples fauna	Portage	Portage		Sherburne		Sherburne	
Genesee...............	Genesee	Genesee	Genesee		Genesee		Genesee

It will thus be seen that the term Chemung has had a very lax usage. The lower limit of the formation has not only been placed at different horizons by the different authors, but has also probably been drawn obliquely across strata of the same age by all but Clarke.

The upper limits of the Chemung is equally lacking in precision. It is known that it descends obliquely across strata of the same age towards the east, owing to the earlier development of Catskill conditions there. It is hence probable that, however defined, the Chemung will embrace different units east and west so that it is questionable whether the term meets the needs of scientific nomenclature.[3]

As employed in the present discussion, the base of the Chemung is drawn in Maryland at the base of the Spirifer disjunctus fauna and its upper limit at the upper limit of the observed marine fauna of the Upper Devonian, since these afford the most precise limits for correlation.

[1] Journal of Geology, vol. xiv, 1906, p. 579.
[2] Bull. N. Y. State Museum, No. 87, 1905, p. 20.
[3] See remarks by J. M. Clarke in Bull. N. Y. State Museum, No. 87, 1905, p. 20.

It is, however, questionable whether it would not be better to define the Chemung simply as the arenaceous phase of the marine Upper Devonian including the Chemung and Parkhead members as here defined. In that case it would have very different limits in different areas and be without definite time value, resembling in this respect the term Catskill. This usage has not been followed, however, in the present case.

The most diagnostic species of the Chemung of New York are *Spirifer disjunctus* and species of the genera *Dalmanella* and *Douvillina*, the Chemung fauna having been called the Spirifer disjunctus fauna by Williams.[1] These are also important members of the Chemung of Maryland and are associated with many other species restricted to the Chemung in New York and in Maryland. The number of species and varieties identified in the Chemung of Maryland is 101, of which 34 are new. Of the 77 species formerly described, 60, or 78 per cent, occur also in the Chemung of New York. A list of the species occurring in these beds is given in the table showing the distribution of species, in which their vertical range and occurrence in other areas are indicated.

The lithological character of the Chemung sediments is the same in both areas and the development of arenaceous sediments below the range of the Chemung faunas is the eastern sections in Maryland is in harmony with the same condition in New York. Moreover, the beds occupy a similar relation to the underlying Portage and overlying Catskill. These facts clearly establish the Chemung age of this member.

A conspicuous feature of the Maryland fauna is the abundant occurrence of species of *Dalmanella* and *Douvillina* west of Wills Mountain, and the almost entire absence of the former genus and the rarity of the latter genus east of that mountain. Williams notes[2] a similar restriction of the species of *Dalmanella* to western and central New York.

The lower shale and sandstone beds correspond in their stratigraphic position to the Cayuta member of the Chemung of New York. They contain certain species which are reported by Williams[3] from that member

[1] Bull. U. S. Geol. Survey, No. 210, 1903, p. 83.

[2] Proceedings of the U. S. National Museum, vol. xxxiv, pp. 35-64.

[3] Folio of the U. S. Geol. Survey, No. 169, 1909, p. 6.

only, in eastern and central New York. These include *Bucanopsis mæra, Loxonema styliolum, Sandbergergoceras chemungensis,* and *Manticoceras patersoni.* They also resemble the Cayuta member in being much more fossiliferous than the overlying strata.

The lower shale and sandstone beds are succeeded by a massive conglomeratic sandstone containing the Tropidoleptus carinatus fauna at many places. There is also a similar recurrence of the Tropidoleptus carinatus fauna at the top of the Cayuta member of New York. In Maryland this fauna has been observed chiefly in the central part of the area and contains the following species, all of which occur in the corresponding zone in New York: *Tropidoleptus carinatus, Spirifer marcyi* var. *superstes, Rhipidomella vanuxemi, Camarotœchia contracta, Ambocœlia umbonata, Spirifer mesacostalis.* The recurrence of a fauna of Hamilton type above the base of the Chemung, in a position similar to that in which it occurs in New York is of great interest and still further indicates the similarity of the conditions under which sedimentation took place in both areas and the probable equivalency of these horizons. A recurrence of the Tropidoleptus carinatus fauna corresponding to its recurrence near the base of the Chemung in New York has not been assuredly observed in Maryland. The Spirifer disjunctus fauna has, however, been found at the base of a section exposed in the axis of a small anticline, situated a short distance east of the house of Mr. Cheney 2.2 miles northeast of Pratt, on the road leading to Fifteenmile Creek. An abundant development of the Tropidoleptus carinatus fauna may be seen on the hilltop a little over 100 feet higher stratigraphically, which strongly suggests the fauna in the upper zone of the Parkhead, while the undoubted upper Tropidoleptus carinatus fauna of the Chemung is seen in different associations in a conglomerate on the hills to the west. It is hence possible that the Spirifer disjunctus fauna may occur below the top of what has been considered the Parkhead member in this locality, in which case the upper zone of that member may represent the lower recurrence of the Tropidoleptus carinatus fauna in the Chemung of New York. The stratigraphic relations are, however, too obscure at this place to permit confident conclusions, while the Spirifer

disjunctus fauna has not been noted in a corresponding position in any of the studied sections, where the stratigraphic relations are clear. These facts suggest a possible lower range of *Spirifer disjunctus* in the western sections of Maryland analogous to the lower range of that species in eastern New York described by Clarke.

The middle shale and sandstone beds occupy a position similar to that of the Wellsburg member of the Chemung of New York, which they also resemble in being more arenaceous than the underlying strata in the eastern and central sections, and in containing fewer fossils. They are, however, more fossiliferous in the Oakland area (15 species having been observed in this division east of the Oakland area 3 of which are new). All but one of the previously described species occur in the Wellsburg member in New York. Most of these species have a considerable stratigraphic range so that they have little value for exact correlation and the equivalency of these horizons is not necessarily established.

The upper conglomerate occupies a position suggesting that of the conglomerate terminating the Wellsburg member in New York. It is, however, not possible to correlate them by faunal features and their identity is not established.

The upper shale and sandstone beds are replaced by Catskill sediments in central and eastern New York so that it is not possible to institute comparison between the upper shale and sandstone bed and the strata of that region. *Athyris angelica* occurs near the top of the Jennings in Maryland and is also found in New York in the Cuba sandstone and overlying beds of the Olean quadrangle[1] in western New York where it appears to be high in the Chemung. Species of *Palæanatina* also occur in the ferruginous upper beds of the Chemung in New York as in Maryland.

The following table shows the relation of the marine Upper Devonian strata of eastern Allegany County, Maryland, to those of central New York.

[1] Bull. of the N. Y. State Museum, No. 69, 1903, p. 992.

MARYLAND	NEW YORK [1]
Chemung sandstone member.	Chemung formation.
Ferruginous shale and sandstone beds. Palæanatina angusta zone at top.	Absent.
Upper Chemung conglomerate.	Fall creek conglomerate. Correlation doubtful.
Middle sandstone and shale, 800 feet thick.	Wellsburg member, sandstone and shale 600 feet thick.
Lower Chemung conglomerate, containing the upper recurrent Tropidoleptus carinatus fauna.	Zone containing upper recurrent Tropidoleptus carinatus fauna.
Lower shale and sandstone beds, 600 feet thick.	Cayuta member, shale and sandstone 600 feet thick.
Parkhead member.	Portage formation.
Parkhead sandstone member containing the recurrent Tropidoleptus carinatus fauna. Beds more arenaceous eastward.	Enfield member. Containing the recurrent Tropidoleptus carinatus fauna. Beds more arenaceous eastward.
Woodmont shale member.	Ithaca shale member.
Beds containing Ithaca fauna. Liorhynchus globuliforme zone.	Liorhynchus globuliforme zone of Ithaca fauna of eastern New York.
Cladochonus-Reticularia lævis zone.	Ithaca fauna of central New York.
Beds containing Naples fauna. Alternating shale and flagstone.	Sherburne member. Containing Naples fauna. Alternating shales and flagstones.
Genesee black shale member.	Genesee black shale formation.
Absent eastward. Genesee fauna.	Absent eastward. Genesee fauna.

CORRELATION WITH PENNSYLVANIA

The Upper Devonian of Pennsylvania has not been studied as fully as that of New York, the criteria available for correlation being chiefly lithological and, hence, attended with much uncertainty. The essential identity of the Upper Devonian deposits of New York and Maryland renders it probable that the sediments of this age in Pennsylvania were laid down under substantially the same conditions. Confident correlation, however, must await fuller paleontological proof than is now possessed.

[1] Williams, H. S., Devonian Section at Ithaca, N. Y. Journal of Geology, vol. xiv, 1906, p. 579.

It has long been recognized by geologists engaged in the study of the Upper Devonian of Pennsylvania that it represents in a general way the Genesee, Portage, Chemung, and Catskill formations of New York. The limits of the formations were drawn, however, at very different horizons by different students. I. C. White,[1] who made an extended study of these strata in Pennsylvania, recognized the presence of two conglomerates which he correlated throughout most of the state by means of their stratigraphic position and lithological characters. He called the upper of these the Lackawaxen conglomerate from a locality on the Delaware River, and stated that it is formed of flat pebbles, some of which are jasper. He named the lower the Allegrippus conglomerate from Allegrippus, Huntingdon County, Pennsylvania. The section exposed in Huntingdon County, Pennsylvania, was interpreted as follows by White:[2]

	Thickness
CATSKILL FORMATION	
Non-marine beds	2525
Hauns Bridge beds (marine fossils)	1000
Lackawaxen conglomerate (3650 feet above base of Upper Devonian).	
Strata below conglomerate, with a fish bed at base	100
CATSKILL-CHEMUNG TRANSITION BEDS	
Containing some bright-red sediments	700
CHEMUNG FORMATION	
Arenaceous sediments, containing the Allegrippus conglomerate 2700 feet above the base of Upper Devonian	1550
Portage flags	1100
Genesee formation	200

The base of the Catskill of Huntingdon County is made by White to correspond, as far as possible, with the base of the Catskill as determined by him on the Delaware River. The fact that the section studied by White in Huntingdon County is on the strike of the Jennings strata west of Green Ridge in Maryland and the close agreement of his measurements with those of the Jennings in the latter area renders it not improbable that the base of White's Chemung occupies approximately the position of the base of the Parkhead sandstone member of Maryland, that the Allegrippus conglomerate which occurs 2700 feet above the base

[1] Rept. 2d Geol. Survey, Pa., vol. T3, 1885, p. 102.
[2] *Ibid.*

of the Genesee in Huntingdon County is the same as the Lower Chemung conglomerate, occurring 2600 to 2700 feet above the base of the Jennings in Maryland, and that the Lackawaxen conglomerate occurring 3659 feet above the base of the section in Pennsylvania is the same as the Upper Chemung conglomerate occurring 3400-3500 feet above the base of the Jennings. In that event the Hauns Bridge beds probably represent the upper sandstone and shale beds of the Chemung of Maryland which are 1200 to 1400 feet thick in the central part of the area, while his non-marine Catskill beds would be the Catskill of this State. This comparison is only tentative in the absence of adequate faunal evidence.

J. J. Stevenson discussed the Upper Devonian of the eastern United States in his Vice-Presidential address delivered before the American Association for the Advancement of Science in 1891.[1] In this paper he states that there are two conglomerates in the Chemung traceable from Tennessee to New York and correlates them throughout that entire area by their lithological character and stratigraphic position.

The following section which is situated immediately north of the Maryland-Pennsylvania state line, in Fulton County, Pennsylvania, is given by Stevenson in his report on the geology of Bedford and Fulton counties.[2]

CATSKILL FORMATION

Red non-marine sediments.

CHEMUNG FORMATION

Shale beds with marine fossils	800
Upper conglomerate, 2810 feet above base of Portage	10
Shale and sandstone	950
Lower conglomerate, 1850 feet above base of Portage	10
Shale	450
Total thickness of Chemung	2220
Portage formation	1400
Total	3620

[1] Proc. A. A. A. S., 1891, vol. xl, p. 219, and Amer. Geol., vol. ix, 1892, p. 6. This paper is quoted in full by Lesley in the Final Rept., 2d Geol. Survey Pa., 1892, vol. ii, pp. 1405-1433.

[2] Rept. 2d Geol. Survey Pa., vol. T2, 1882, p. 75.

Stevenson correlates his upper conglomerate with White's Lackawaxen conglomerate.

A section measured by the author in Thompson Township, Fulton County, Pennsylvania, renders it probable that Stevenson's upper conglomerate occupies approximately the position of White's Allegrippus conglomerate, in Fulton County, while his lower conglomerate is probably

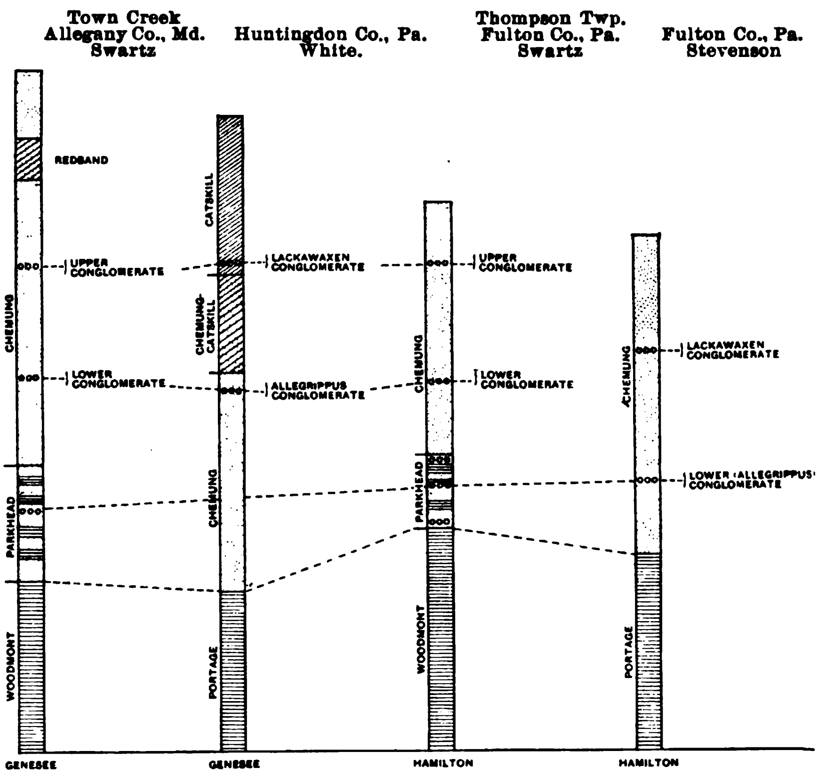


FIG. 2.—Diagram showing the correlation of Marine Upper Devonian of Maryland and Pennsylvania.

the upper conglomerate of the Parkhead sandstone member, illustrating the difficulty of correlating the strata over large areas by the use of the conglomerates.

The relation of the Maryland section to those of White and Stevenson is suggested tentatively in the preceding diagram, although fuller paleontological data are needed before confident conclusions can be drawn.

THE CATSKILL FORMATION

The Catskill formation of Maryland is nearly barren, no fossils other than underterminable vegetable fragments and a few poorly preserved pelecypods having been found in it. It closely resembles the Catskill of New York in its lithological character, in the absence of marine fossils, and in its increasing thickness eastward, where it replaces the upper Chemung sediments.

The similarity in lithological character, conditions of sedimentation, geographical distribution, and its continuity with the Catskill of Pennsylvania and New York fully justify its correlation with them.

The range of the fossils of the Upper Devonian of Maryland is given in the subjoined table which also shows their occurrence in the Ithaca fauna at Catawissa, Pa.,[1] and in the Upper Devonian of central New York.[2] The range of the species in Maryland is also shown in greater detail upon the chart of columnar sections (contained in pocket) in which the species are indicated by the numerals prefixed to their names in the table.

[1] Kindle and Williams, Bull. U. S. Geol. Survey, No. 244, 1905, p. 78.

[2] The occurrence of species in the *Liorhynchus globuliforme zone* and in the Ithaca of Central N. Y. cited in columns referred to Williams, is from Folio of the U. S. Geol. Survey, No. 169, 1909, p. 6. The occurrence in Ithaca fauna of Central N. Y. cited in column referred to Clarke is from Bull., N. Y. State Museum, No. 82, 1905, p. 55.

GEOLOGICAL RANGE OF UPPER DEVONIAN FAUNA IN MARYLAND, PENNSYLVANIA AND NEW YORK.

		Maryland													Pennsylvania	New York							
			Jennings Formation																Portage Format'n				
				Woodmont Member				Chemung Member												Ithaca Member			
					Ithaca Fauna			Area east of Oakland											Centr'l N. Y.				
	SPECIES	Romney Formation, Hamilton Member	Genesee Member	Naples Fauna	Cladochonus—Reticularia lævis Zone	Liorhynchus globuliforme Zone	Parkhead Member	Lower shale and sandstone beds	Lower conglomerate	Middle shale and sandstone beds	Upper conglomerate	Upper shale and sandstone beds	Horizon undetermined	Oakland Area	Ithaca Fauna	Hamilton Formation	Genesee Formation	Sherburne Member	Williams	Clarke	Liorhynchus globuliforme Zone	Enfield Member	Chemung Formation
	CŒLENTERATA—ANTHOZOA.																						
1	Zaphrentis marylandica Clarke & Swartz	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..
2	Zaphrentis chemungensis Clarke & Swartz	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..
3	Heliophyllum scrutarium Clarke & Swartz	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..
4	Favosites sp.	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..
5	Aulopora repens Knorr & Walch	..	..	..	..	..	*	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..
6	Cladochonus humilis Clarke & Swartz	..	..	..	†	..	..	*	..	..	..	..	..	..	..	..	..	..	**	..	..	..	..
	ECHINODERMATA—ASTEROIDEA.																						
7	Paleaster clarki Clarke & Swartz	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..
	VERMES.																						
8	Spirorbis gyrus Clarke & Swartz	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..
9	Spirorbis sp.	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
10	Pteridichnites beseriatus Clarke & Swartz	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	MOLLUSCOIDEA—BRACHIOPODA.																						
11	Lingula oherni Clarke & Swartz	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
12	Lingula ligea Hall	?	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	*	..	..	..
13	Lingula spatulata Vanuxem	..	..	..	..	*	..	..	..	..	..	..	..	..	..	*	*	*	..	*	*	*	..
14	Lingula sp.	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
15	Orbiculoidea cf. media (Hall)	*	..	..	..	..	*	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..
16	Craniella hamiltoniæ Hall	*	..	..	..	..	*	*	..	..	..	..	..	..	..	*	*	..	*	*	*	*	..
17	Craniella ? sp.	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
18	Crania sp.	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..
19	Stropheodonta demissa (Conrad)	*	..	..	*	*	..	..	..	..	..	..	..	*	*	*	..	..	*	*	*	..	..
20	Stropheodonta maynardi Clarke & Swartz	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
21	Leptostrophia perplana var. nervosa (Hall)	¶	..	..	..	..	..	..	..	..	..	..	..	‡	*	¶	..	..	..	*	..	..	*
22	Leptostrophia perplana var. alternata C. & S.	¶	..	..	..	..	..	*	..	..	..	*	..	*	..	¶	..	..	..	..	..	..	..
23	Leptostrophia interstrialis (Vanuxem)	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	?	*	*	*	..	*
24	Douvillina cayuta (Hall)	..	..	..	..	..	..	†	..	†	..	*	..	*	..	..	..	..	..	*	..	..	*
25	Douvillina cayuta var. graciliora C. & S.	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..
26	Douvillina arcuata (Hall)	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	*
27	Strophonella reversa (Hall)	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	*
28	Strophonella sp.	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..
29	Schuchertella chemungensis (Conrad)	..	..	..	..	..	..	‡	..	‡	..	‡	..	‡	..	..	..	..	*	*	..	*	*
30	Schuchertella elliptica Clarke & Swartz	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..
31	Schuchertella ? ponderosa Clarke & Swartz	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
32	Chonetes lepidiformis Clarke & Swartz	..	..	..	..	..	*	..	..	..	..	..	..	..	..	¶	¶	¶	¶	..	..	..	..
33	Chonetes scitulus Hall	*	..	..	..	..	*	†	..	*	..	..	..	..	*	*	..	..	*	*	*	*	*
34	Chonetes oaklandensis Clarke & Swartz	..	..	..	..	..	..	..	..	*	..	..	..	†	..	..	..	..	..	..	..	..	..

† = abundant, ‡ = common, § = rare, ‖ = very rare, ¶ = related form, ** = compare.

The numbers preceding the names of the fossils refer to the occurrences of these species as shown upon the chart of columnar sections of the Jennings Formation of Maryland (in pocket of this volume).

GEOLOGICAL RANGE OF UPPER DEVONIAN FAUNA IN MARYLAND, PENNSYLVANIA AND NEW YORK.—Continued.

		SPECIES	MARYLAND													PENNSYLVANIA	NEW YORK							
				Jennings Formation															Portage Format'n					
					Woodmont Member				Chemung Member											Ithaca Member				
						Ithaca Fauna			Area east of Oakland											Centr'l N. Y.				
			Romney Formation, Hamilton Member	Genesee Member	Naples Fauna	Cladochonus—Reticularia lævis Zone	Liorhynchus globuliforme Zone	Parkhead Member	Lower shale and sandstone beds	Lower conglomerate	Middle shale and sandstone beds	Upper conglomerate	Upper shale and sandstone beds	Horizon undetermined	Oakland Area	Ithaca Fauna	Hamilton Formation	Genesee Formation	Sherburne Member	Williams	Clarke	Liorhynchus globuliforme Zone	Enfield Member	Chemung Formation
		MOLLUSCOIDEA—BRACHIOPODA.—Cont'd.																						
35		Chonetes rowei Clarke & Swartz						•																
36		Productella lachrymosa (Conrad)						•	‡						•						•			•
37		Productella lachrymosa var. marylandica C. & S.							•						•									
38		Productalla lachrymosa var.							•						•									
39		Productella speciosa Hall				†	†									•				•	•		•	
40		Productella hystricula Hall													•									•
41		Productella navicelliformis Clarke & Swartz						•																
42		Productus (Marginifera ?) hallanus Walcott													•									•
43		Dalmanella tioga (Hall)							†															•
44		Dalmanella carinata (Hall)							•															•
45		Dalmanella sp.							•															
46		Rhipidomella vanuxemi (Hall)	•					•		•							•				•	•	•	•
47		Schizophoria striatula (Schlotheim)	?			†	†	§	•						•	•				•	•	•		•
48		Schizophoria striatula var. marylandica C. & S.									•		•		‡									
49		Camarotœchia congregata var. parkheadensis Clarke & Swartz	¶					•		•							¶				¶			
50		Camarotœchia contracta (Hall)							•	•	•		†											•
51		Camarotœchia contracta (Hall) small variety									•													
52		Camarotœchia horsfordi (Hall)						•			?						•				•			
53		Camarotœchia orbicularis (Hall)									•				•									•
54		Camarotœchia eximia (Hall)						•			•		†			•	•			•	•	•	•	•
55		Liorhynchus mesacostale Hall						•								•			?	•				
56		Liorhynchus cf. multicostum Hall						•													•		•	
57		Liorhynchus globuliforme (Vanuxem)				§	†									?					•	•		
58		Pugnax pugnus var. altus Calvin				•	‡									•				•	•	•		
59		Cryptonella cf. eudora Hall											•		•	•				•		•		•
60		Tropidoleptus carinatus (Conrad)	•					†		†						•	•				•		•	•
61		Atrypa reticularis (Linné)	•			†	•	•				•	•		‡	•	•			•	•	•	•	•
62		Atrypa spinosa Hall					•	•	†		‡	•			•	•	•							•
63		Atrypa hystrix Hall									•				‡									•
64		Cyrtina hamiltonensis Hall	•				†	•	‖						•	•	•		•	•	•	•		•
65		Reticularia lævis (Hall)				•										•			•	•	•	•	•	
66		Spirifer disjunctus Sowerby							†	•	†		†		†									•
67		Spirifer mesastrialis Hall				•	•	‖	†	•	†	•				•				•	•			•
68		Spirifer marcyi var. superstes Clarke & Swartz						†		†							¶				¶		¶	¶
69		Spirifer mucronatus var. posterus Hall & Clarke	¶			†	†	‖								•	¶				•	•		
70		Spirifer (Delthyris) mesacostalis Hall						†	†		†	•	•				¶				•	•	•	•
71		Ambocœlia umbonata (Conrad)	•					‖	†	•	†	•	•		†	†	•		?		•	•	•	•
72		Athyris angelica Hall											•											•
73		Meristella humilis Clarke & Swartz				•																		
		MOLLUSCA—PELECYPODA.																						
75		Grammysia elliptica Hall						•			•		•							•		•		•
74		Grammysia subarcuata Hall						•			•								•	•			•	•

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GEOLOGICAL RANGE OF UPPER DEVONIAN FAUNA IN MARYLAND, PENNSYLVANIA AND NEW YORK.—Continued.

No.	SPECIES	Maryland: Romney Formation, Hamilton Member	Maryland: Jennings Formation: Genesee Member	Maryland: Jennings Formation: Woodmont Member: Naples Fauna	Maryland: Jennings Formation: Woodmont Member: Ithaca Fauna: Cladochonus—Reticularia lævis Zone	Maryland: Jennings Formation: Woodmont Member: Ithaca Fauna: Liorhynchus globuliforme Zone	Maryland: Jennings Formation: Parkhead Member	Maryland: Jennings Formation: Chemung Member: Area east of Oakland: Lower shale and sandstone beds	Maryland: Jennings Formation: Chemung Member: Area east of Oakland: Lower conglomerate	Maryland: Jennings Formation: Chemung Member: Area east of Oakland: Middle shale and sandstone beds	Maryland: Jennings Formation: Chemung Member: Area east of Oakland: Upper conglomerate	Maryland: Jennings Formation: Chemung Member: Area east of Oakland: Upper shale and sandstone beds	Maryland: Jennings Formation: Chemung Member: Area east of Oakland: Horizon undetermined	Maryland: Jennings Formation: Chemung Member: Oakland Area	Pennsylvania: Ithaca Fauna	New York: Hamilton Formation	New York: Genesee Formation	New York: Portage Format'n: Sherburne Member	New York: Portage Format'n: Ithaca Member: Centr'l N. Y.: Williams	New York: Portage Format'n: Ithaca Member: Centr'l N. Y.: Clarke	New York: Portage Format'n: Ithaca Member: Liorhynchus globuliforme Zone	New York: Portage Format'n: Enfield Member	New York: Chemung Formation
	MOLLUSCA—PELECYPODA.—Continued.																						
76	Grammysia communis Hall					*																	*
77	Grammysia undata Hall ?											*											*
78	Palæanatina angusta Hall ?													*									*
79	Sphenotus contractus Hall										*	*		*									*
80	Sphenotus sp.												*										
81	Buchiola retrostriata (V. Buch.)		*	*													*	*					
82	Buchiola conversa Clarke		*															*					
83	Buchiola mariæ Clarke & Swartz		*																				
84	Buchiola ? livoniæ Clarke		*	*													*	*		*			
85	Paracardium doris Hall		*	*													*	*				*	
86	Paracardium delicatulum Clarke		*														*						
87	Nucula corbuliformis Hall	*				*	*	*						*	*	*			?	*	*		
88	Nuculites sp.																						
89	Palæoneilo constricta (Conrad)	*			*						*			*	*	*		*	?	*			
90	Palæoneilo plana Hall	*				*	*	*				*			*	*		*		*	*	*	*
91	Palæoneilo petila Clarke			*														*					
92	Palæoneilo cf. maxima (Conrad)	*					*									*				*			
93	Palæoneilo brevis Hall					‡	*								*				*	?	*	*	
94	Palæoneilo filosa (Conrad)							*							*			*	*	*			*
95	Palæoneilo angusta Hall													*									*
96	Palæoneilo crassa Clarke & Swartz											*		*									
97	Leda diversa Hall	*					*			*		*				*				*			
98	Leda sp.									*													
99	Macrodon chemungensis Hall						*																*
100	Pterinea nodocosta Clarke & Swartz													*									*
101	Pterinea chemungensis (Conrad)					*	*	‡		‡				‡	*					*			*
102	Lunulicardium encrinitum Clarke		*														*						
103	Lunulicardium cymbula Clarke & Swartz		*																				
104	Pterochænia fragilis (Hall)		*	*													*	*	?	*		*	
105	Ectenodesma birostratum Hall					†									*					*			
106	Liopteria bigsbyi Hall						*			*					?	*				*			
107	Liopteria sp. (near bigsbyi)									*													
108	Liopteria marylandica Clarke & Swartz							*															
109	Liopteria auriculata Clarke & Swartz				*																		
110	Liopteria sp.													*									
111	Leptodesma rogersi Hall	*												*					*	*	*	*	
112	Leptodesma longispinum Hall							*						*									*
113	Leptodesma agassizi Hall									?				*									*
114	Leptodesma medon Hall									†				*									*
115	Leptodesma naviforme Hall						*													*			
116	Leptodesma lichas Hall											*		*									*
117	Leptodesma elongatum Clarke & Swartz											*											
118	Leptodesma sp.							*		*		*											

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GEOLOGICAL RANGE OF UPPER DEVONIAN FAUNA IN MARYLAND, PENNSYLVANIA AND NEW YORK.—Continued.

	SPECIES	Maryland													Pennsylvania	New York							
			Jennings Formation															Portage Format'n					
				Woodmont Member				Chemung Member											Ithaca Member				
					Ithaca Fauna			Area east of Oakland											Centr'l N. Y.				
		Romney Formation, Hamilton Member	Genesee Member	Naples Fauna	Cladochonus—Reticularia lævis Zone	Liorhynchus globuliforme Zone	Parkhead Member	Lower shale and sandstone beds	Lower conglomerate	Middle shale and sandstone beds	Upper conglomerate	Upper shale and sandstone beds	Horizon undetermined	Oakland Area	Ithaca Fauna	Hamilton Formation	Genesee Formation	Sherburne Member	Williams	Clarke	Liorhynchus globuliforme Zone	Enfield Member	Chemung Formation
	MOLLUSCA—PELECYPODA.—Continued.																						
119	Gosselletia sp.	..	..	..	..	..	..	§	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
120	Actinopteria cf. epsilon Hall	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	*	..	*	..	..
121	Actinopteria cf. boydi (Conrad)	¶	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..
122	Ptychopteria sp.	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
123	Ptychodesma ? sp.	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
124	Schizodus chemungensis (Conrad) ?	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	*	*	..	..	*
125	Schizodus chemungensis var. quadrangularis H.	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	*
126	Schizodus oherni Clarke & Swartz	..	..	..	..	..	*	*	..	*	..	*	..	..	..	..	..	..	..	..	..	..	..
127	Schizodus oherni var.	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..
128	Schizodus frostburgensis Clarke & Swartz	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..
129	Schizodus trigonalis Clarke & Swartz	..	..	..	..	..	*	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
130	Aviculopecten cf. cancellatus Hall	..	..	..	..	..	*	..	..	..	..	..	..	..	..	*	..	..	..	*	..	..	..
131	Aviculopecten ? sp.	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..
132	Lyriopecten tricostatus (Vanuxem)	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	*	*	..	*
133	Modiomorpha subangulata Hall var.	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*
134	Goniophora hamiltonensis Hall	*	..	..	..	*	*	..	..	..	..	..	..	..	..	*	..	..	..	*	..	..	..
135	Goniophora truncata Hall	..	..	..	..	..	*	..	..	..	..	..	..	..	*	*	..	..	..	*	..	..	..
136	Goniophora glauca Hall	..	..	..	..	..	*	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..
137	Cypricardella bellistriata (Conrad)	*	..	..	..	..	*	..	..	..	..	..	..	..	..	*	..	..	?	*	..	*	..
138	Cypricardella marylandica Clarke & Swartz	..	..	..	..	..	..	?	..	..	..	*	..	‡	..	..	..	..	..	..	..	..	..
139	Cypricardella marylandica ? var. (very small)	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
140	Cypricardella gregaria (Hall)	..	..	..	..	..	*	..	..	..	..	..	..	..	*	*	..	..	*	*	..	..	*
141	Cypricardella gregaria var.	..	..	..	..	..	*	..	..	*	..	..	..	*	..	..	..	..	..	..	..	..	..
142	Cypricardella tenuistriata (Hall)	*	..	..	..	..	*	§	..	..	..	..	..	..	..	*	..	..	..	*	..	..	..
143	Cypricardella nitidula Clarke & Swartz	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..
144	Cypricardella cumberlandiæ Clarke & Swartz	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..
145	Cypricardella crassa Clarke and Swartz	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
146	Cypricardella sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
147	Cypricardinia elegans Clarke & Swartz	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..
148	Cypricardinia elegans var. angusta C. & S.	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..
149	Paracyclas marylandica Clarke & Swartz	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..
150	Paracyclas sp.	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..
	MOLLUSCA—GASTROPODA.																						
151	Pleurotomaria sp.	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
152	Pleurotomaria (Gyroma) capillaria Conrad	*	..	..	..	..	*	..	..	..	..	..	..	..	..	*	..	*	*	?	*	*	..
153	Murchisonia sp.	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..
154	Hormatoma bistriata Clarke & Swartz	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
155	Ectomaria marylandica Clarke & Swartz	..	..	..	..	..	*	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
156	Ectomaria ecclesiæ Clarke & Swartz	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..
157	Bellerophon nactoides Clarke & Swartz	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
158	Bellerophon clarki Clarke & Swartz	..	..	..	..	..	†	‖	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

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GEOLOGICAL RANGE OF UPPER DEVONIAN FAUNA IN MARYLAND, PENNSYLVANIA AND NEW YORK.—Continued.

		MARYLAND													PENNSYLVANIA	NEW YORK							
			Jennings Formation																Portage Format'n				
				Woodmont Member				Chemung Member												Ithaca Member			
					Ithaca Fauna			Area east of Oakland												Centr'l N. Y.			
	SPECIES	Romney Formation, Hamilton Member	Genesee Member	Naples Fauna	Cladochonus—Reticularia lævis Zone	Liorhynchus globuliforme Zone	Parkhead Member	Lower shale and sandstone beds	Lower conglomerate	Middle shale and sandstone beds	Upper conglomerate	Upper shale and sandstone beds.	Horizor undetermined	Oakland Area	Ithaca Fauna	Hamilton Formation	Genesee Formation	Sherburne Member	Williams	Clarke	Liorhynchus globuliforme Zone	Enfield Member	Chemung Formation
	MOLLUSCA—GASTROPODA.—Continued.																						
159	Bellerophon sp.					*																	
160	Bucanopsis mæra (Conrad)					*	*	*							*					?			*
161	Straparollus marylandicus Clarke & Swartz						*																
162	Phænerotinus laxus (Hall)						*									*				*			
163	Euomphalus tioga Hall													*									
164	Cyclonema concinnum Hall						*	*															*
165	Cyclonemina crenulistriata Clarke & Swartz							*															
166	Cyclonemina crenulistriata var. obsolescens Clarke & Swartz							*															
167	Cyclonemina multistriata Clarke & Swartz						*	*															
168	Turbo coronula Clarke & Swartz													*									
169	Trochonema (Gyronema) liratum (Hall)	*						*								*							
170	Trochonema (Gyronema) sp.											*											
171	Macrochilina pulchella Clarke & Swartz												*										
172	Loxonema hamiltoniæ Hall	*					*									*							
173	Loxonema terebrum Hall							*						*									*
174	Loxonema styliolum Hall							†		*												*	*
175	Loxonema ? glabrum Clarke & Swartz						†	*															
176	Trachydomia præcursor (Clarke)													*				?	?	?		*	
177	Holopea rowei Clarke & Swartz						*						*										
178	Holopea marylandica Clarke & Swartz									*													
179	Holopea humilis Clarke & Swartz						*	*															
180	Holopea ? sp.											*											
181	Orthonychia prosseri Clarke & Swartz													*									
182	Orthonychia unguiculata Clarke & Swartz						*																
183	Orthonychia sp.						*																
184	Platyceras marylandicum Clarke & Swartz						*																
185	Platyceras compressum Clarke & Swartz								*														
186	Platyceras sp.																						
187	Diaphorostoma lineatum (Conrad)	*											*			*							
	MOLLUSCA—PTEROPODA.																						
188	Styliolina fissurella (Hall)	*	*														*	*		*			
189	Tentaculites descissus Clarke & Swartz													*									
190	Tentaculites spiculus Hall				*										*					?			
191	Coleolus tenuicinctus Hall	*					†		*							*							
192	Hyolithes aclis Hall						*									*							
193	Pharetrella tenebrosa Hall		*														*						
	MOLLUSCA—CEPHALOPODA.																						
194	Orthoceras consortale Hall							*															*
195	Orthoceras cf. demum Hall						*					*											*
196	Orthoceras filosum Clarke		*	*														*					

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GEOLOGICAL RANGE OF UPPER DEVONIAN FAUNA IN MARYLAND, PENNSYLVANIA AND NEW YORK.—Continued.

	SPECIES	Maryland: Romney Formation, Hamilton Member	Maryland, Jennings Formation: Genesee Member	Maryland, Jennings Formation, Woodmont Member: Naples Fauna	Maryland, Jennings Formation, Woodmont Member, Ithaca Fauna: Cladochonus—Reticularia lævis Zone	Maryland, Jennings Formation, Woodmont Member, Ithaca Fauna: Liorhynchus globuliforme Zone	Maryland, Jennings Formation: Parkhead Member	Maryland, Jennings Formation, Chemung Member, Area east of Oakland: Lower shale and sandstone beds	Maryland, Jennings Formation, Chemung Member, Area east of Oakland: Lower conglomerate	Maryland, Jennings Formation, Chemung Member, Area east of Oakland: Middle shale and sandstone beds	Maryland, Jennings Formation, Chemung Member, Area east of Oakland: Upper conglomerate	Maryland, Jennings Formation, Chemung Member, Area east of Oakland: Upper shale and sandstone beds	Maryland, Jennings Formation, Chemung Member, Area east of Oakland: Horizon undetermined	Maryland, Jennings Formation, Chemung Member: Oakland Area	Pennsylvania: Ithaca Fauna	New York: Hamilton Formation	New York: Genesee Formation	New York, Portage Format'n: Sherburne member	New York, Portage Format'n, Ithaca Member, Centr'l N. Y.: Williams	New York, Portage Format'n, Ithaca Member, Centr'l N. Y.: Clarke	New York, Portage Format'n, Ithaca Member: Liorhynchus globuliforme Zone	New York, Portage Format'n: Enfield Member	New York: Chemung Formation
	MOLLUSCA—CEPHALOPODA.—Continued.																						
197	Bactrites aciculus (Hall)	*	*	..	..	..	..	..	..	..	..	..	..	..	..	..	*	*	*	*	..	*	..
198	Manticoceras patersoni (Hall)	..	..	*	..	..	..	*	..	..	..	..	..	..	..	..	*	*	*	*	..	..	*
199	Probeloceras lutheri Clarke ?	..	*	*	..	..	..	..	..	..	..	..	..	..	..	..	..	*	*	..	..	..	..
200	Tornoceras uniangulare (Conrad)	..	*	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	*	..	..	..
201	Sandbergeroceras chemungensis (Vanuxem)	..	..	..	..	..	*	*	..	?	..	..	..	..	..	..	..	..	.	..	..	..	*
	ARTHROPODA—CRUSTACEA.																						
202	Phacops rana (Green)	*	..	..	..	..	*	..	..	..	.	..	..	..	..	*	..	..	?	*	..	*	..
	VERTEBRATA—PISCES.																						
203	Glyptaspis eastmani Clarke & Swartz	..	..	..	..	..	*	..	..	..	.	..	..	..	..	..	..	..	..	..	.	..	..

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LOCAL SECTIONS OF THE UPPER DEVONIAN[1]

THE JENNINGS FORMATION

The Jennings formation outcrops in a number of narrow areas, the longer axes of which trend northeast and southwest, parallel to the Appalachian Mountains. At least one and where possible several sections have been studied in each area.[2]

Marked differences exist between the strata east and west of Wills Mountain. In the following discussion, therefore, the sections east of Wills Mountain have been grouped in one division and those west of Wills Mountain in another. The various sections of each area are brought together, while the areas are considered in order from east to west.[3]

Sections East of Wills Mountain

I. Section East of Millstone[4]

An extended section of the Jennings is exposed east of the village of Millstone, beginning at the Romney-Jennings contact in the village and extending eastward along the National Road and in the cuts of the Western Maryland Railroad which parallels that road, for a distance of 6500 feet. It ends at the axis of the syncline in which the strata are contained. The lower part of the section is partially concealed and is so complicated by minor folds that the measurements of it are not deemed trustworthy and hence are not employed in the discussion. A bed occurring 2706 feet east of the beginning of the section and abounding in *Camarotœchia congregata* var. *parkheadensis* is taken as a datum plane and is placed at an altitude of 1600 feet above the base of the Jennings,

[1] Contributed by Charles K. Swartz.

[2] Graphic sections are shown on pl. vi (in pocket at end of volume).

[3] The writer is greatly indebted to D. W. Ohern, T. P. Maynard, and J. T. Singewald, Jr., for assistance in the study of the sections described in this chapter. The sections in large part were first measured, described, and the fossils collected by Ohern and Maynard. The critical points were then studied in detail by the writer, who alone is responsible for the conclusions presented.

[4] Measured by pacing. The strike of rocks is taken as N. 35° E. throughout the entire calculation.

which is approximately the elevation at which the same bed occurs in the section west of Berkeley Springs, West Virginia, where the lower strata are well exposed and free from minor folding. The identity of the beds at both places is established by the sequence and by the contained faunas. This is the most easterly section in Maryland and is admirably exposed.

JENNINGS FORMATION *Chemung Sandstone Member* Section Measured on Railroad Road N. 60° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Concealed. A conglomerate at top, containing *Camarotœchia contracta ?* small variety, *Schizodus oherni* abundant	6503	73	3116
Axis of minor syncline	6123		
Green sandstone with shale partings. Average dip 12° E	6123	20	3042
Flaggy green sandstone shale partings. Dip 50° E.	6023	22.8	3022
Hackly and splintery red and green shale with carbonaceous matter	5993	9.5	2999
Massive red and green sandstone. Dip 23° E.	5968	46	2990
Railroad culvert	5848		2944
Massive brown and green sandstone	5848	24.9	2944
Massive brown and green sandstone and interbedded shale. Dip 30° E. Containing at the top *Spirifer disjunctus* common, cf. *Leda* sp., *Leptodesma* sp.	5798	24.9	2919
Splintery red shale. Dip 15° E.	5748	39.8	2894
Massive red and green sandstone	5593	6.7	2854
Red shale breaking irregularly. Dip 15° E.	5563	29.6	2848
Concealed. Red shales and sandstone in part. Containing at 5365 horizontally (2796 vertically) *Spirifer mesastrialis*	5448	33.5	2818
Massive red sandstone and some shale	5318	9	2785
Hackly red shale and sandstone	5283	14.1	2776
Hackly red shale and some sandstone. A conglomeratic sandstone at top containing *Spirifer mesastrialis*, *Cypricardella crassa* abundant	5228	12.8	2761
Hackly shale and concretionary sandstone with a bed of flaggy sandstone at bottom. Dip 15° E. Containing at top *Spirifer mesastrialis* abundant	5178	14.7	2749
Green and brown sandstone and hackly shale	5138	12.8	2734
Red shale with hackly and splintery fracture	5103	64.5	2721
Red shale and sandstone	4928	5.4	2657
Olive-green and red shale breaking irregularly. Dip 22° E. Marked spheroidal weathering	4913	83	2651

Road N. 72° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Concealed	4688	61	2568
Deep ravine. Old road leading N	4548		
Concealed	4548	50.5	2507
Olive-green and red shale	4428	12.4	2457
Olive-green and red arenaceous shale. In a sandstone at the top occur *Schuchertella ? ponderosa*, *Spirifer disjunctus*, *S. mesastrialis* very abundant	4398	54.5	244
Olive-green shale breaking irregularly. An arenaceous shale at top contains *Spirifer disjunctus* very abundant, *S. mesastrialis*	4268	46.5	2390
Massive olive-green sandstone. At top occurs *Spirifer mesastrialis*	4158	14.5	2343
Fissile olive-green shale	4123	6.5	2329
Green hackly arenaceous shale and thin beds of sandstone. Containing at the top *Ambocœlia umbonata* common, *Chonetes scitulus* abundant, *Spirifer* (*Delthyris*) *mesacostalis*, *Palæoneilo plana*, *Schizodus oherni*	4108	21	2322
Green arenaceous shale breaking irregularly	4058	46.5	2301
Splintery red shale. Dip 25° E. Containing at the top *Ambocœlia umbonata*, *Chonetes scitulus*, *Spirifer* (*Delthyris*) *mesacostalis* ? *Cypricardella* sp	3948	10.5	2255
Green shale breaking irregularly and weathering yellow.	3923	25.9	2244
Red shale breaking irregularly. Dip 48° E	3888	37.4	2218
Green shale. Dip 30° E	3838	50	2181
Concealed	3738	8	2131
Ravine	3718		
Concealed	3718	10	2123
Third railroad crossing east of Millstone	3688		
Green shale and brown flaggy sandstone. Dip 20° E	3688	34	2113
Shale and sandstone. At top *Chonetes* sp	3588	17	2079
Parkhead Sandstone Member			
Red sandstone with partings of bluish and greenish shale	3548	17	2062
Green and blue sandstone with shale partings	3508	12.5	2045
Greenish sandstone conglomeratic in places and interbedded shale	3478	8.5	2033
Coarse conglomerate, containing at top *Spirifer mesastrialis*	3458	8.5	2024
Coarse massive green sandstone	3438	4	2016
Bluish shale and green flaggy sandstone	3428	17	2012
Bluish shale weathering yellow	3388	36	1995
Bluish shale breaking irregularly	3303	5	1959
Green shale breaking irregularly	3291	8.5	1954

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Bluish arenaceous shale	3271	2	1945
Arenaceous shale	3266	8.3	1943
Green arenaceous shale breaking irregularly	3246	6.5	1935
Green shale and bands of flaggy sandstone	3231	17	1928
Concealed. A heavy sandstone in interval	3191	115.5	1911
Railroad crossing of Western Maryland Railroad	3011		
Concealed	3011	12.4	1794
Coarse gray sandstone, containing *Spirifer mesastrialis*, *Tropidoleptus carinatus*, *Platyceras marylandicum*, *Cypricardella gregaria*, var. more elongate than usual, *Schizodus trigonalis* ?, *S. oherni*. abundant	2991	9.3	1781
Red fissile shale	2976	29	1772
Green shale	2931	12.4	1743
Massive fine-grained red sandstone	2911	2.5	1731
Greenish-gray massive fine-grained sandstone	2907	9.3	1728
Argillaceous shale	2892	1.2	1719
Massive green sandstone	2890	2.5	1718
Smooth green shale	2886	6.2	1715
Massive green sandstone	2876	3.1	1709
Olive-green hackly and smooth shale	2871	25.4	1706
Olive-green shale breaking irregularly	2836	22.5	1680
Smooth olive-green shale. Dip 40° E.	2796	58	1658
Brown sandstone carrying *Camarotœchia congregata* var. *parkheadensis* in profusion associated with *C. eximia* and *Spirifer* (*Delthyris*) *mesascostalis*	2706	1	1600

Woodmont Shale Member

BEDS CONTAINING ITHACA FAUNA

Green shale breaking irregularly	2704	5.4	1599
Massive red sandstone	2696	2.5	1595
Green shale and sandstone. Dip 30° E.	2691	7	1592
Massive green sandstone	2677	4.5	1585
Rough green shale	2670	17.8	1581
Concretionary shaly green sandstone, small fault	2642	15	1563

Road N. 50° W.

Massive fine-grained green sandstone	2619	17.8	1548
Fissile green shale	2591	54	1530
Fissile brown shale	2508	33.8	1476
Massive fine-grained brown sandstone. Dip 43° E.	2458	10	1443
Hackly brown shale and sandstone	2443	7.5	1433

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Smooth red shale	2433	11.1	1425
Rough green shale	2419	9	1414
Brown shale and sandstone	2407	9	1405
Massive brown fine-grained sandstone	2396	7.5	1396
Splintery brown shale	2385	3	1388
Brown shale and sandstone showing spheroidal weathering. Dip 54° E.	2381	6.5	1385
Fissile brown shale and bands of brown sandstone	2373	40	1379
Fissile green shale	2308	24	1339
Concealed. Dip 38° E. Whistle post	2268	15	1315
Fissile green shale and bands of green sandstone	2243	15	1300
Fissile brown shale	2223	34	1285
Concealed	2178	15	1251
Road N. 60° W.			
Fissile brown shale	2158	23	1236
Fissile brown and green shale	2128	39	1213
Rough green shale	2078	25	1174
Rough brown shale. At top a band of sandstone 4 inches thick carrying *Liorhynchus globuliforme* abundant, *Productella speciosa*, *Spirifer mucronatus* var. *posterus*	2046	8	1149
Rough brown shale, narrow band of sandstone at top carries *Spirifer mucronatus* var. *posterus*, and *Bucanopsis mæra* var. abundant	2036	19	1141
Green hackly shale and sandstone. At top occur *Cyrtina hamiltonensis* common, *Liorhynchus globuliforme* abundant, *Productella speciosa* abundant, *Spirifer mucronatus* var. *posterus*	2011	6	1122
Concealed	2028	19	1116
Massive hard grayish-green sandstone	2003	4	1097
Concealed. Dip 52° E.	1998	14	1093
Red shale	1980	22	1079
Fissile brown shale. At top in a band of sandstone about 8 inches thick occur *Liorhynchus globuliforme*, *Schizophoria striatula*, *Spirifer mucronatus* var. *posterus*	1950	37	1057
Olive-green fissile shale and occasional bands of green or brown flaggy sandstone. Dip 48° E.	1900	85	1020
Concealed along both railroad tracks and National Road	1785	81	935
Olive-green shale with bands of green and brown flaggy sandstone	1675	59	853

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green shale breaking irregularly and bands of sandstone. Shales covered with a yellowish-brown rust. N. 63° E. 48° E. In a band of sandstone at top are found *Meristella humilis*, *Productella speciosa* abundant, *Pugnax pugnus* var. *altus*, *Spirifer mucronatus* var. *posterus* small, *Leptostrophia interstrialis*, *Tentaculites spiculus*, *Liopteria auriculata*. This exposure is seen on National Road 45 feet east of point where road turns from north to east........	1595	28	795
Railroad crossing	1565		767
Section continued on National Road			
Concealed. Thickness unknown	1565		
Road leading to northeast. Railroad station at Millstone	945		
Concealed	945		
Green and brown shale and bands of sandstone N. 37° E. 48° E...	915	22	
Concealed	885		
Green shale and green gnarly sandstone	860	31	
BEDS CONTAINING NAPLES FAUNA. UPPER LIMIT APPROXIMATE			
Fissile green shale and flaggy sandstone. N. 43° E. 52° E...	820	82	
Brown and green fissile shale	815	26	
Fissile brown shale	780	26	
Fissile green shale and flaggy green sandstone. N. 42° E. 50° E...	745	30	
Concealed	705		
Ravine	665		
Concealed	665		
Fissile brown shale and bands of brown sandstone.....	625	15	
Fissile green shale and green sandstone...............	605	23	
Green and brown shale and green sandstone N. 50° E. 50° E...	575	23	
Green and brown shale and green sandstone N. 65° E. 25° E...	545	29	
Green and light-brown hackly shale and bands of green sandstone	475	72	
Concealed. Opposite Millstone Hotel	395		
Fissile green shale and bands of green sandstone N. 30° E. 65° E..	340	135	
Green shale breaking irregularly. Dip 45° E..........	190	63	

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Fissile green shale	100	18	
Green arenaceous shale breaking irregularly. Dip 38° E	70	42	
Romney-Jennings contact	0	0	

ROMNEY FORMATION

Massive sandstone with imprints of *Spirophyton* sp.

The characteristic features of the Jennings formation are well displayed in this section. The Romney-Jennings contact is sharply shown. The basal beds of the Woodmont member, containing the Naples fauna, consist of interbedded olive-green fissile shales and thin flaggy sandstones. The overlying beds carrying the Ithaca fauna consist more largely of shale, which is softer and less distinctly fissile. The Parkhead sandstone member contains three zones of conglomeratic sandstone. The lowest conglomerate is inconspicuous and consists of a single stratum abounding in *Camarotœchia congregata* var. *parkheadensis*, which is a most persistent and valuable datum plane in all the eastern sections. The middle conglomeratic sandstone is very massive and forms the crest of the ridge. The upper conglomeratic sandstone, which is thicker and more massive here than at any other locality in the State, contains bluish-white quartz pebbles often of large size. Because of its conspicuous character the latter bed has been selected as the top of the Parkhead sandstone member on the geological map of the region east of Sideling Hill.

The Chemung sandstone member contains a very notable proportion of red beds which make their appearance near the base of the Chemung and are more conspicuous here than in any of the sections west of this point. The massive sandstone beds forming the ridge in the center of the syncline may represent the lower Chemung conglomerate (the Tropidoleptus conglomerate) of the most westerly sections. The upper conglomerate of the Chemung is not exposed at this place but the massive sandstones which represent it are to be seen south of the Potomac River.

The Naples, Ithaca, Parkhead, and Chemung faunas are all well developed. Their characteristics will be considered later.

II. Section Along Yellow Springs Run[1]

An excellent section of the lower part of the Jennings is exposed on the road leading from Berkeley Springs to New Hope, West Virginia, along Yellow Springs Run, 3 miles east of Berkeley Springs. It begins 1793 feet east of the point where the road crosses the north fork of the Run and extends westward 2392 feet.

JENNINGS FORMATION / *Chemung Sandstone Member* / Road N. 75° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Concealed. A fine-grained conglomeratic sandstone occurs at the top of this interval	2393	162	2147
Parkhead Sandstone Member			
Road S. 58° W.			
Concealed. At the top of this unit massive brown conglomeratic sandstone is exposed, at the first turn west of the bridge. Fragments of the conglomerate are seen in the field north of the road	2193	190	1985
Road N. 65° W.			
Center of bridge over north fork of Yellow Springs Run.	1793		
Concealed in part. A massive brown sandstone 20 feet thick occurs 1742 to 1762 feet vertically. N. 23° E. 55° W.	1793	77.8	1795
Smooth green shale. N. 23° E. 55° W.	1698	24.5	1717
Green shale breaking into irregular fragments. A brown conglomeratic sandstone 15 inches thick at base of unit.	1668	12.2	1693
Smooth green shale. N. 25° E. 40° W.	1653	38.5	1680
Arenaceous shale breaking irregularly	1593	4.5	1642
Green shale breaking irregularly	1586	16	1637
Green shale breaking irregularly. Thin beds of fine-grained sandstone at top. At the bottom of this unit occurs a conglomeratic sandstone containing *Camarotœchia congregata* var. *parkheadensis* abundant, and *Spirifer* (*Delthyris*) *mesacostalis* abundant	1561	21.5	1621

[1] Measured by pacing.

Woodmont Shale Member BEDS CONTAINING THE ITHACA FAUNA	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Arenaceous shale and sandstone of deep-red color	1526	28.9	1600
Green shale. N. 25° E. 65° W.	1481	108	1571
Red shale breaking irregularly	1361	31.7	1463
Red shale and hard red sandstone N. 26° E. 50° W.	1326	65.1	1431
Green sandstone and shale	1241	7.6	1366
Fissile green shale	1231	45.6	1359
Red shale breaking irregularly	1171	8.3	1313
Green and red shale N. 35° E. 53° W.	1160	26	1304
Coarse shale, irregular fracture, red and green sandstones	1125	7.6	1279
Green and red shale and sandstone. Ravine to the left, house on the right	1115	26.8	1271
Concealed	1080	22.8	1244
Green fissile shale. N. 35° E. 50° W. At the bottom were found *Cyrtina hamiltonensis* abundant, *Liorhynchus globuliforme* abundant, *Productella speciosa* abundant, *Spirifer mucronatus* var. *posterus*	1050	50	1222
Red and green shale breaking irregularly	970	22.6	1162
Coarse green shale containing at the bottom *Cyrtina hamiltonensis*, *Liorhynchus globuliforme* abundant, *Productella speciosa*, *Spirifer mucronatus* var. *posterus*, *Grammysia communis*	940	15	1139
Green and brown shale breaking irregularly and some sandstone. N. 22° E. 60° W. At the bottom of this unit, 840 feet west of beginning of section occur *Productella speciosa*, *Schizophoria striatula* abundant, *Spirifer mesastrialis*, *S. mucronatus* var. *posterus* abundant	920	69	1124
Beginning of section permitting estimates of thickness..	840		1055
East of this point the folding is too intricate to permit the determination of thickness. The following species occur at the positions indicated below:			
Atrypa reticularis, *Cyrtina hamiltonensis*, *Productella speciosa* abundant, *Schizophoria striatula* abundant, *Spirifer mucronatus* var. *posterus* abundant, *Stropheodonta demissa*, *Cypricardella* ? sp., *Pterinea chemungensis*	660		
Meristella humilis, *Productella lachrymosa* ?, *P. speciosa* abundant, *Pugnax pugnus* var. *altus*, *Schizophoria striatula* abundant, *Spirifer mesastrialis*, *S. mucronatus* var. *posterus* abundant	510		
Chonetes lepidiformis ?, *Liorhynchus globuliforme*, *Productella speciosa* common, *Spirifer mesastrialis*, *Ectenodesma birostratum*	270		

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Productella speciosa, *Spirifer mesastrialis* common, *S. mucronatus* var. *posterus*, *Nucula corbuliformis Palæoneilo brevis*, *Bellerphon* sp. small resembles *clarki*	110		
At the beginning of the section are found: *Cyrtina hamiltonensis*, *Liorhynchus globuliforme* abundant, *Pugnax pugnus* var. *altus*, *Spirifer mucronatus* var. *posterus*	0		

The lower part of the section is so complicated by minor folding that the measurements of it are deemed untrustworthy and are not employed. The bed containing *Camarotœchia congregata* var. *parkheadensis*, occurring 1526 feet from the beginning of the section, is selected as a datum plane and is placed 1600 feet above the base of the Jennings, approximately at the horizon at which it occurs in the section east of Berkeley Springs. The *Liorhynchus globuliforme zone* of the Ithaca fauna is very fossiliferous at this locality. A conspicuous feature of the section is the brilliant red bed of Catskill-like sediments that occurs just below the *Camarotœchia congregata* var. *parkheadensis* bed and which is found in the same position in many of the sections as far west as Tonoloway.

Sections were measured in the Hancock area at Berkeley Springs, Hancock, on the Hancock-Harrisonville road and in Thompson Township, Fulton County, Pennsylvania.

III. Section East of Berkeley Springs [1]

The section described is exposed on the Yellow Springs Run road, east of Berkeley Springs, West Virginia, beginning at the Romney-Jennings contact, just west of the house of Mr. Ruppenhals, one-half mile east of the village and extending eastward 3284 feet. It is admirably exposed, free from minor folds, rich in fossils and is the most satisfactory section for the correlation of the lower strata of the Jennings observed in the eastern part of the area studied.

[1] Measured by tape.

JENNINGS FORMATION *Chemung Sandstone Member* Road N. 49° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Concealed. *Spirifer mesastrialis* abundant at top	3284	130	2158
Road N. 25° W.			
Concealed	3084	130	2028
Parkhead Sandstone Member			..
Concealed. A massive brown conglomeratic sandstone at top 15 feet thick. Dip 37° E..........................	2844	27	1898
House	2784		
Concealed	2784	102	1871
Concealed. A massive gray sandstone at top 12 feet thick containing *Camarotœchia congregata* var. *parkheadensis*, *Tropidoleptus carinatus*, *Spirifer* (*Delthyris*) *mesacostalis*.	2554	75.2	1769
Fork of road	2384		
Road N. 63° W.			
Concealed in part, exposing some fissile olive-green shale. N. 18° E. 40° E....................................	2384	127.5	1694
Massive greenish-gray sandstone. In fragments found on hillside north of road were found *Camarotœchia congregata* var. *parkheadensis*, abundant, *C. congregata* var. with deeper sinus, suggesting *contracta*, *Spirifer* (*Delthyris*) *mesacostalis*, *Cypricardella gregaria* var., *Cylconemina multistriata*. Thickness of sandstone approximate	2214	12	1566
Woodmont Shale Member			
BEDS CONTAINING ITHACA FAUNA			
Very red shale having a bed of green sandstone 18 inches thick at bottom	2194	30	1554
Fissile olive-green shale	2144	39	1524
Olive-green shale breaking irregularly	2079	6	1485
Fissile olive-green shale	2069	30	1479
Red shale	2019	18	1449
Concealed	1989	9	1431
Green sandstone	1974	12	1422
Fissile brown shale	1954	24	1410
Massive brown sandstone	1914	3	1386
Red shale	1909	12	1383
Red shale containing at top *Productella speciosa* abundant, *Schizophoria striatula*, *Spirifer mucronatus* var. *posterus* abundant	1889	12	1371
Fissile green shale	1869	43.6	1359

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Fissile red shale	1809	11	1316
Olive-green shale containing thin beds of green sandstone. Shale rusty	1794	69	1305
Olive-green shale of varied physical character	1699	72.7	1236
Hackly green shale and a few thin beds of brown shale containing the following fossils at top: *Cyrtina hamiltonensis* abundant, *Liorhynchus globuliforme*, *Productella speciosa* abundant, *Pugnax pugnus* var. *altus* abundant, *Spirifer mucronatus* var. *posterus*	1599	69.1	1163
N. 20° W. 50° E.			
Brown shale and sandstone	1504	13.5	1094
Hackly green shale containing at top N. 15° E. 40° E. *Liorhynchus globuliforme*, *Productella speciosa* abundant, *Pugnax pugnus* var. *altus*, *Schizophoria striatula*, *Spirifer mucronatus* var. *posterus*, crinoid rings	1482	6	1080
Green shale breaking irregularly containing *Productella speciosa* common and *Spirifer mucronatus* var. *posterus*, *Palæoneilo brevis* ?	1472	10.5	1074
Green hackly arenaceous shale, containing *Productella speciosa* abundant at top. N. 15° E. 40° E	1455	6	1064
Green hackly shale and thin beds of fine-grained green sandstone. At top occur *Pugnax pugnus* var. *altus*, *Lingula spatulata*, *Liorhynchus globuliforme*, *Schizophoria striatula*, *Productella speciosa*, *Spirifer mucronatus* var. *posterus*. N. 25° E. 60° E	1445	47.5	1058
Green shale, very fissile at bottom, becoming gradually more hackly above, containing *Spirifer mucronatus* var. *posterus* at top	1390	185	1010
Road N. 80° W.			
Green shale of varied character containing *Cladochonus humilis* abundant at top	1120	39	825
Hackly green shale, one bed chocolate-colored, containing the following fossils at top of unit: *Atrypa reticularis*, *Schizophoria striatula* common	1065	14.1	786
Arenaceous green shale breaking irregularly	1045	17.5	772
Green shale breaking irregularly containing the following fossils at the top: *Cladochonus humilis*, *Atrypa reticularis*, *Productella speciosa*, *Reticularia lævis*, *Spirifer mucronatus* var. *posterus*	1020	10.5	755

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Fissile green shale	1005	32	744
Fissile olive-green shale and thin beds of green sandstone, N. 5° E. 45° E. Containing the following fossils at top of unit: *Atrypa reticularis* abundant, *Lingula spatulata*, *Liorhynchus globuliforme* common, *Reticularia lævis* abundant, *Spirifer mucronatus* var. *posterus*, *Stropheodonta demissa* common	960	89	712
BEDS CONTAINING NAPLES FAUNA			
Road N. 85° W.			
Concealed	840	43	623
Ravine	790		
Concealed	790	48.5	590
Largely concealed. The bank along the road indicates strata possessing the same general character as the following unit, save that sandstone beds are more numerous. Dip 45° E. New house on the north side of road	720	243	532
Road N. 80° W.			
Fissile olive-green shale interbedded with thin layers of flaggy sandstone, bearing crinoid segments at top. N. 20° E. 45° E	370	126	289
Fissile olive-green shale. N. 23° E. 50°	220	74.3	163
Largely concealed. N. 23° E. 50° E	120	88.5	88
Romney-Jennings contact			0

ROMNEY FORMATION

Massive sandstone.

The occurrence of a zone of *Reticularia lævis* in the lower part of the Ithaca fauna is of special interest because of the restricted range of that species in New York, while the overlying *Liorhynchus globuliforme zone* is well developed. The conglomerate containing *Camarotœchia congregata* var. *parkheadensis,* which forms the base of the Parkhead, is found in numerous fragments on the hillside and is underlain by the conspicuous red band that frequently occurs in this position in eastern Maryland.

IV. Section on National Road East of Hancock[1]

The Jennings is exposed on the National Road east of Hancock. The lower part of the section is concealed in part and is also complicated by minor folds, as shown by the measurements and by the geological structure of the area, so that earlier students were led to false estimates of the thickness of these strata.

The section described begins at the Romney-Jennings contact, 200 feet east of the center of the bridge over Little Run east of Hancock, and extends 6737 feet eastward to the Jennings-Catskill contact.

CATSKILL FORMATION

Red shale and sandstone.

JENNINGS FORMATION *Chemung Sandstone Member* Road N. 77° E.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Jennings-Catskill contact	6737		3989
Concealed	6737	161	3989
Toll-gate house near fork of road	6537		
Concealed	6537	161	3828
Yellow shale, poorly exposed, fossiliferous near the top	6337	95	3667
Dark-red shale	6217	15	3572
Brown shale, weathering yellow green	6197	15	3557
Dark-red shale	6177	8	3542
Road N. 59° W.			
Argillaceous yellow and green shale	6167	15	3534
Arenaceous chocolate-red shale N. 5° E. 52° E	6147	7	3519
Argillaceous chocolate-brown sandstone	6137	21	3512
Chocolate-red shale	6112	17	3491
Dark-yellow shale	6092	34	3474
Dark-purple sandstone	6052	1	3450
Arenaceous shale	6051	25	3449
Dark-purple sandstone	6021	1	3424
Chocolate-brown shale	6020	17	3423
Argillaceous sandstone and arenaceous shale N. 5° E. 70° E. containing at top *Spirifer mesastrialis* abundant	6000	4	3406

[1] Measured by pacing.

Road S. 47° E.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Concealed, massive conglomeratic sandstone at top, 20 feet thick	5995	322	3402
Concealed. Massive gray sandstone at top. N. 7° E. 60° E.	5565	150	3080
Road S. 50° E.			
Concealed to east end of bridge over creek. Massive conglomeratic sandstone at about 4800 feet from beginning of section (2627 feet above base of Jennings) seen in creek bed	5365	401	2930
Concealed. *Spirifer disjunctus* found on slope of hill west of creek, altitude about 2275 feet above base of Jennings	4815	301	2529
Road N. 17° E.			
Argillaceous shale and some sandstone N. 17° E. 60°. At 4185 horizontally (2223 vertically) *Ambocœlia umbonata* abundant, *Chonetes scitulus*, *Spirifer mesastrialis*, *Gyronema liratum*, *Orthoceras* cf. *demum*	4465	10	2228
Road N. 75° E.			
Largely concealed. Argillaceous sandstone and shale. *Chonetes scitulus*	3895	254	2218
Parkhead Sandstone Member.			
Argillaceous sandstone and shale. A conglomeratic sandstone near top	3565	123	1974
Sandstone and shale. A conglomeratic sandstone with large white pebbles at base of unit	3405	23	1851
Yellow sandy shale, more argillaceous above, breaking irregularly and weathering to a reddish tint. N. 7° E. 56° E.	3375	177	1828
Yellow arenaceous shale and sandstone. Some dark-red sandstone	3145	51	1651
Yellow, fine-grained conglomeratic sandstone containing *Camarotœchia congregata* var. *parkheadensis* abundant, *C. eximia*, *Spirifer* (*Delthyris*) *mesacostalis*, *Tropidoleptus carinatus* N. 7° E. 40° E.	3077	1	1600

Woodmont Shale Member BEDS CONTAINING ITHACA FAUNA	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Dark-red argillaceous sandstone, several thin beds of yellowish-green shale. Yellow sandstone interbedded in upper 15 feet. N. 5° E. 30° E. *Lingula ligea* was found loose on road, probably from this unit	3075	35	1599
Argillaceous yellow shale breaking very irregularly and weathering yellowish-brown. N. 25° E. 30° E.	3000	30	1564
Axis of minor anticline	2920		1525
Same as preceding beds	2920	4	1525
Yellow and red sandstone and shales	2910	60	
Concealed in part. Fragments of dark-yellow conglomeratic sandstone, same as at 3077 horizontally, loose on hillside	2770	50	
Loose fragments of conglomeratic sandstone, same as at 3077 horizontally, containing *Camarotœchia congregata* var. *parkheadensis* in abundance. N. 15° E. 40° E.	2680		1600
Reddish-brown fine-grained sandstone and yellow shale..	2680	50	1600
Concealed	2590	276	1550
Coarse arenaceous shale. At the top of this unit back of the third of four similar houses occur *Liorhynchus globuliforme*, *Spirifer mucronatus* var. *posterus* abundant. Between 2020 and 2180 were found *Cyrtina hamiltonensis* common, *Lingula spatulata*, *L. ligea*, *Liorhynchus globuliforme* abundant, *Productella speciosa*, *Spirifer mesastrialis*, *S. mucronatus* var. *posterus* abundant, *Nucula corbuliformis*, *Palæoneilo brevis*	2180	43	1274
Road N. 85° E.			
Coarse arenaceous shale, second of four similar houses opposite top of unit. N. 15° E. 60° E. At top was found *Productella speciosa*, *Spirifer mucronatus* var. *posterus* abundant	2120	82	1231
Coarse arenaceous shale breaking irregularly. At top of this unit, behind the first of four similar houses, occur *Productella speciosa* and *Spirifer mucronatus* var. *posterus* abundant	2020	155	1149
Yellow arenaceous shale containing at top *Cladochonus humilis*, *Productella speciosa*, *Pugnax pugnus* var. *altus* ?, *Spirifer mucronatus* var. *posterus* ? N. 9° E. 70° E.	1850	59	994
Yellow argillaceous shale. At top occur *Reticularia lævis* ?, *Spirifer mucronatus* var. *posterus*. N. 7° E. 56° E.	1785	166	935
Axis small anticline. No deduction made for folding...	1580		
Light-colored argillaceous shale, weathering to a reddish-brown tone, some chocolate-colored shale	1580	81	769

Road S. 83° E.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Concealed	1480	16	688
Ravine	1450		
About 300 feet northeast of the road, on the strike of the rock, there were found in the shale behind a barn the following fossils: *Cladochonus humilis*, *Atrypa reticularis* common, *Productella speciosa* abundant, *Pugnax pugnus* var. *altus*, *Schizophoria striatula* abundant, *Reticularia lævis* abundant, *Spirifer mucronatus* var. *posterus*, *Stropheodonta demissa*. The vertical altitude at which these forms occur is approximately 690 feet.			
Concealed. Minor folding probably occurs in this interval	1450	351	672
BEDS CONTAINING NAPLES FAUNA			
Largely concealed. In part olive-green shales and interbedded flaggy sandstone. Beds vary arenaceous at top. N. 7° E. 37° E	480	106	321
Ravine	300		
Concealed	300	19	215
Olive-green fissile shale with interbedded flaggy sandstone	270	26	196
Same as above containing at the top Buchiola speciosa fauna. N. 8° E. 40° E	230	64	170
Same as above containing Buchiola speciosa fauna. N. 16° E. 55° E	130	74	106
Concealed	40	32	32
Romney-Jennings contact	0		0

ROMNEY FORMATION

Very massive sandstone.

Though not well exposed, this is one of the first sections of the lower Jennings that was carefully studied in Maryland. The *Camarotœchia congregata* var. *parkheadensis* bed, forming the base of the Parkhead member, is selected as a datum plane and placed 1600 feet above the base of the Jennings, this being approximately the position at which the same bed occurs at Berkeley Springs, West Virginia. Among the most conspicuous features of the section is the *Cladochonus-Reticularia lævis zone,* which occurs near the base of the beds containing the Ithaca fauna (690

to 1000 feet vertically) and is a horizon of importance for correlation with the New York section. The *Liorhynchus globuliforme zone* is well developed above this (1000 to 1600 feet vertically). The conglomerate at the base of the Parkhead is finely exposed and abounds in *Camarotœchia congregata* var. *parkheadensis*. It is underlain by a red bed which suggests the Catskill lithologically, and shows that Catskill conditions had probably already begun in some adjacent area. The Parkhead contains three conglomeratic zones, above which the beds consist more largely of shale. These are in turn overlain by more arenaceous beds of the Chemung seen on the west bank of Great Tonoloway Creek east of the turn of the road, in which the Spirifer disjunctus fauna makes its appearance.

V. Section on Hancock-Harrisonville Road [1]

This section is exposed on the Hancock-Harrisonville road, which leads eastward from Cove Ridge, not quite one-half mile north of the Maryland-Pennsylvania State line. It is located in Fulton County, Pa., about 2 miles northeast of Hancock. The section begins at the Romney-Jennings contact and extends eastward 1505 feet. It affords a good exposure of the lower strata of the Jennings.

JENNINGS FORMATION *Woodmont Shale Member* BEDS CONTAINING ITHACA FAUNA Road N. 85° E.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Ravine	1505		
Shale breaking into irregular fragments	1505	87.3	1104
Fissile olive-green shale	1385	29.1	1017
Hackly olive-green shale, containing at the top *Atrypa reticularis*	1345	43.3	988
Coarse olive-green shale breaking irregularly, containing at the top *Atrypa reticularis* abundant, *Productella speciosa*, *Pugnax pugnus* var. *altus*, *Schizophoria striatula*, *Spirifer mucronatus* var. *posterus*. N. 17° E. 60° E.	1280	62	944
Green shale fissile at bottom, breaking irregularly at top. Thin beds of sandstone N. 22° E. 55° E., containing at the top *Atrypa reticularis* abundant, *Productella speciosa* abundant, *Pugnax pugnus* var. *altus*, *Schizophoria striatula*, *Spirifer mucronatus* var. *posterus*, *Stropheodonta demissa*, *Leptostrophia interstrialis*	1213	156.7	882

[1] Measured by pacing.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Olive-green shale. Some beds of sandstone. Some red beds. N. 15° E. 56° E. Containing at the top *Cladochonus humilis* abundant, *Atrypa reticularis*, *Pugnax pugnus* var. *altus*, *Schizophoria striatula* abundant, *Spirifer mucronatus* var. *posterus*	995	85.8	726
BEDS CONTAINING NAPLES FAUNA			
Olive-green shale with beds of fine-grained flaggy sandstone. N. 12° E. 50° E. Some beds of shale covered with bright-red rust	885	265.6	640
Second-class road to left	520		
Road N. 95° E.			
Dark olive-green fissile shale N. 20° E. 40°	520	65.2	374
Road N. 80° E.			
Dark olive-green fissile shale N. 20° E. 47° E	415	133	309
Olive-green fissile shale	230	15.3	176
Fissile dark shale. N. 11° E. 50° E. At top occur *Buchiola* sp., *Pterochænia* sp	210	160.8	161
Romney-Jennings contact	0		0

ROMNEY FORMATION

Massive sandstone.

VI. Section in Thompson Township, Fulton County, Pennsylvania [1]

The section extends along a road leading from Great Tonoloway Creek to Timber Ridge, about 1.9 miles north of the Maryland-Pennsylvania line. It begins a short distance northeast of the point at which the road enters the area embraced in the Hancock quadrangle of the U. S. Geological Survey and ends 833 feet east of the intersection of this road with another road leading north and south on top of the first ridge east of the Great Tonoloway Creek.

[1] Measured from 0 to 3036 by pacing, from 3036 to top by tape.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
CATSKILL FORMATION			
Strata above 3869 horizontally are prevailingly red.			
Road S. 85° W.			
Light-green shale	3869	10.5	
Red shale	3851	18	
Light-green sandy shale	3821	6.5	
Road S. 58° W.			
Concealed	3811	18	
Red shale. N. 18° E. 43° E	3761	8.5	
Yellow-green sandstone, 4 inches thick	3737	0.5	
Red shale	3736	1	
Green shale	3734	5	
Road N. 95° W. Map altitude 700 feet			
Yellowish-brown shale	3720	10.5	
Light-green shale, sandy below. N. 18° E. 43° E	3701	4	
Red shale. Thin green band near bottom	3694	14	
Road N. 80° W.			
Red sandstone N. 18° E. 43° E	3669	2	
Green sandy shale	3666	3	
Red sandy shale	3661	11.5	
Thickness of Catskill described		113	
JENNINGS FORMATION			
Chemung Sandstone Member			
Jennings-Catskill Contact	3462		3837
Green shale, sandy near bottom, *Camarotœchia* sp., etc., at top N. 18° E. 45° E	3642	22.5	3837
Road N. 46° W.			
Red shale and thin bedded shaly sandstone	3616	5	3814
Light green shale, sandstone near bottom	3607	3	3809
Green sandstone N. 15° E. 44° E	3602	0.5	3806
Green shale. *Camarotœchia* sp., etc	3601	6	3806
Red shale and thin sandstone	3590	5	3800
Red sandstone	3579	1	3795
Green shale	3577	3.5	3794
Red shale, 6 inches of red sandstone in middle	3570	3.5	3790

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green arenaceous shale and sandstone	3563	5	3787
Red arenaceous shale and sandstone	3554	7.5	3782
Red sandstone	3540	0.5	3774
Red shale and thin sandstone	3539	12	3774
Green shale	3517	1	3762
Red and green shale	3515	4	3761
Green sandstone	3508	1	3757
Red shale	3507	7	3756
Concealed	3494	24	3749
Yellow shaly sandstone, *Camarotœchia* sp..............	3448	2	3725
Red sandy shale. Base of red band. N. 15° E. 42° E.....	3443	32	3723
Road N. 32° W. Map altitude 720 feet			
Yellow to yellowish-green arenaceous shale.............	3381	34	3691
Red to yellowish-green shale	3310	14	3657
Road N. 85° W.			
Concealed	3280	37	3643
Road S. 77° W. Map altitude 740 feet.			
Green and brown, thin-bedded sandstone N. 15° E. 55° E.	3226	9	3606
Red shale	3213	7	3597
Concealed	3203	11	3590
Red arenaceous shale, sandstone below	3187	11	3579
Thin-bedded shaly green sandstone	3171	10	3568
Thin-bedded shaly red sandstone	3156	2	3558
Concealed	3153	11	3556
Thin-bedded shaly brown sandstone N. 15° E. 58° E....	3138	11	3545
Yellowish-green arenaceous shale	3122	1	3534
Red shale	3121	8	3533
Thin-bedded red shaly sandstone, Dip 58° E.............	3109	32	3525
Concealed	3062	17	3493
Road S. 85° E. Map altitude 790 feet			
Cross roads on top of ridge	3036		
Concealed	3036	128	3476
Brown and green arenaceous shale. Mostly concealed..	2896	73	3348
Brown arenaceous shale, some brown sandstone	2816	54	3275
Grayish-green sandstone	2756	7	3221
Brown shale breaking irregularly. Dip 65° E..........	2734	23	3201

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Road N. 55° E. Map altitude 780 feet			
Interbedded yellow, green, and brown arenaceous shale	2709	37	3178
Thin-bedded brown sandstone, some interbedded brown arenaceous shale	2649	9	3141
Brown arenaceous shale	2634	11	3132
Green sandstone. Some brown sandstone on top	2614	15	3121
Green and brown hackly shale	2609	39	3106
Road N. 85° E.			
Brown and green shale breaking irregularly. Dip 50°	2539	58	3067
Brown arenaceous shale with 2 feet massive yellowish-green sandstone at top carrying abundant crinoid rings	2469	33	3009
Road S. 75° E. Map altitude 720 feet			
Concealed. Dip 55° E	2429	132	2976
Road N. 45° E. Map altitude 730 feet			
Brown arenaceous shale. Some interbedded green arenaceous shale	2279	47	2844
Yellowish-green arenaceous shale	2179	9	2797
Brown arenaceous shale breaking irregularly	2159	10	2788
Road N. 35° E. Map altitude 690 feet			
Yellowish-green argillaceous shale. Some thin-bedded green sandstone	2139	60	2778
Road N. 60° E.			
Green argillaceous shale	1959	30	2718
Road N. 85° E.			
Brown and green arenaceous shale, 18 inches green sandstone at top. Dip 50° E	1909	16	2688
Brown arenaceous shale, some green arenaceous shale near top. Green sandstone 1 inch thick at top	1889	12	2672
Yellow and green argillaceous shale	1874	70	2660
Conglomerate sandstone and some interbedded shale forming hilltop. Sandstone in three beds	1784	11	2590
Yellowish-green argillaceous shale	1770	21	2579

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Road S. 60° E.			
Yellowish-green argillaceous shale. Some interbedded green sandstone. Dip 50° E.	1774	44	2558
Green sandstone, interbedded yellowish-green shale	1684	17	2514
Yellowish-green argillaceous shale	1664	8	2507
Reddish-brown arenaceous shale. Thin-bedded brown sandstone at top. This unit is almost bright-red	1654	17	2499
Massive red-brown sandstone	1634	12	2472
Road S. 35° E. Map altitude 630 feet			
Massive red-brown sandstone	1620	11	2460
Yellow shale	1604	23	2449
Red shale	1571	14	2426
Massive sandstone	1551	3	2412
Yellow and reddish-brown shale	1546	18	2409
Road S. 37° E.			
Reddish and yellowish-green arenaceous shale. Some thin beds brown and green sandstone	1520	163	2391
Reddish-brown arenaceous shale	1290	18	2228
Yellowish-green argillaceous shale. Dip 55° E.	1265	21	2210
Road S. 57° E. Map altitude 620 feet			
Yellowish-green, somewhat fissile arenaccous shale	1235	106	2089
Concealed	115	134	2083
Interbedded brown sandstone and shale. Greenish-yellow arenaceous shale at top	965	37	1949
Parkhead Sandstone Member			
Interbedded sandstone and shale. Coarse conglomeratic sandstone at top	925	34	1912
Thin-bedded reddish-brown sandstone. Dip 70° E.	885	9	1878
Yellowish-green arenaceous shale, breaking somewhat irregularly	875	90	1869
Limit of Hancock quadrangle. Map altitude 580 feet.	825		
Thin-bedded grayish-green sandstone	775	9	1779
Yellowish-green arenaceous shale breaking somewhat irregularly	765	36	1770
Conglomeratic grayish-green sandstone, very massive	725	9	1734
Yellowish-green arenaceous shale, breaking somewhat irregularly, some green sandstone	715	125	1725

Road S. 60° E.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Shale. Conglomeratic sandstone at top containing *Camarotœchia congregata* var. *parkheadensis* abundant.........	575	4	1600
Woodmont Shale Member			
BEDS CONTAINING ITHACA FAUNA			
Reddish-brown and green shale	570	37	1596
Thin-bedded yellowish-green sandstone and arenaceous yellowish-green shale	530	23	1559
Yellowish-green arenaceous shale	505	50	1536
Yellowish-green arenaceous shale with coarse-grained conglomerate at top 7 inches thick	450	36	1486
Yellowish-green arenaceous shale. At top of this unit a fine-grained conglomerate 18 inches thick. Dip 60° E.....	410	150	1450
Road S. 55° E.			
Concealed. A conglomerate 1 inch thick at top. Ithaca fauna near base including *Liorhynchus globuliforme*, *Productella speciosa*, *Pugnax pugnus* var. *altus*, *Spirifer mucronatus* var. *posterus*	240	213	1300
Beginning of section at a second-class road leading to south 825 feet northwest of limits of Hancock quadrangle..	0		1087

This section was studied chiefly for its lithological features. It presents an excellent exposure of the strata near the Jennings-Catskill contact, the alternation of sediments of Jennings and Catskill type occurring near the top of the Jennings formation being well shown. It also exhibits the topographic features of the Chemung admirably, the sandstones occupying the horizon of the upper conglomerate forming the chief ridge, while the lower conglomerate forms a smaller ridge on the flanks of the larger. An unusual feature is the development of conglomerates in strata that correspond to the Woodmont member in sections farther west.

VII. Section East of Woodmont Station[1]

One of the best sections of the lower Jennings in the State is seen between Woodmont and Tonoloway stations, nearly opposite Great Caca-

[1] Measured by tape.

pon, West Virginia. This is the locality from which the Woodmont member is named. The strata, which stand nearly vertical, are exposed in the cuts of the Western Maryland Railroad, where there is an uninterrupted section of the lower 1400 feet, rivalling the section at Berkeley Springs, West Virginia, in its excellence. The section is somewhat thinner than usual, due probably to the compression of the strata in the west limb of the anticline, a feature frequently seen in Appalachian folds. It begins at the Romney-Jennings contact west of Tonoloway Station, and extends westward along the railroad 1291 feet, from which point it is continued on the hillside north of the railroad.

JENNINGS FORMATION *Chemung Sandstone Member* Section Exposed on Hillside	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Ravine	2281		
Concealed	2281	97	2249
Schoolhouse	2181		
Concealed	2181	485	2152
Concealed, N. 23° E. 77° W. At top occurs *Ambocœlia umbonata* abundant, *Spirifer disjunctus*. Crinoid rings	1681	72	1667
Parkhead Sandstone Member			
Concealed. A sandstone at top	1601	112	1595
Massive brown sandstone	1487	29	1483
Concealed	1460	69	1454
Concealed. Massive brown sandstone at top, 6 feet thick, bearing *Camarotœchia congregata* var. *parkheadensis*. *Tropidoleptus carinatus*	1391	21	1385
Concealed. Brown sandstone at top	1370	16	1364
Concealed. Conglomerate 1 foot thick at top. Dip 84° W	1354	56	1348
Concealed. Conglomerate at top, 8 inches thick, containing *Camarotœchia congregata* var. *parkheadensis* abundant	1298	7	1292
Top of section on railroad	1291		1285
Massive green sandstone containing at top *Camarotœchia congregata* var. *parkheadensis*, *C. congregata* var. with deeper sinus suggesting *contracta*, *C. eximia*, *Cypricardella tenuistriata*	1291	25	1285

Woodmont Shale Member BEDS CONTAINING ITHACA FAUNA	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green fissile shale	1266	105	1260
Brown fissile shale. Dip 87° W	1161	33	1155
Green fissile shale	1128	36	1122
Brown and green concretionary sandstone	1092	19	1086
Green smooth shale, containing at top *Bryozoa*, *Chonetes lepidiformis* ?, *Cyrtina hamiltonensis*, *Liorhynchus globuliforme*, *Productella speciosa* abundant, *Schizophoria striatula* common, *Spirifer mucronatus* var. *posterus* abundant, *Actinopteria* cf. *boydi*, cf. *Palæoneilo brevis*	1073	35.5	1067
Concretionary sandstone grading into green shale. At top are found *Crytina hamiltonensis* common, *Liorhynchus globuliforme* common, *Productella speciosa* abundant, *Schizophoria striatula*, *Spirifer mucronatus* var. *posterus* abundant, *Palæoneilo brevis*, *Ectenodesma birostratum*. At 1030 horizontally (1020 vertically) were found *Cyrtina hamiltonensis*, *Liorhynchus globuliforme* abundant, *Productella speciosa*, *Pugnax pugnus* var. *altus*, *Spirifer mucronatus* var. *posterus*	1038	27	1032
Olive-green shale and concretionary sandstone	1011	68	1005
Red shale	943	20	937
Olive-green fissile shale. Dip 90° W	923	141	917
Olive-green shale. At top were found *Productella speciosa*, *Spirifer mucronatus* var. *posterus*. Dip. 83° W. At 735 horizontally (728 vertically). *Pugnax pugnus* var. *altus* was found	782	65.3	776
Olive-green shale, some interbedded sandstone. At top occur *Productella speciosa*, *Spirifer mucronatus* var. *posterus*, *Palæoneilo constricta*, *P. brevis*. At 520 horizontally (515 vertically) occurs *Atrypa reticularis*	716	239	710
BEDS CONTAINING NAPLES FAUNA			
Green shale and flaggy sandstone	477	65	471
Concealed	412	117	406
Road leading north	295		
Olive-green fissile shale and bands of flaggy sandstone	295	17	289
Olive-green shale weathering to an ashen-white	278	8.5	272
Olive-green fissile shale with bands of flaggy olive-green sandstone. Dip 84° W. increasing to 90° W. at top of unit	269	220	264
Olive-green fissile shale	46	44	44
Romney-Jennings contact	0		0

ROMNEY FORMATION	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Sandstone and some interbedded shale which break irregularly		32	
Massive sandstone.			

The lithological features of the lower Jennings are well displayed. The basal beds contain the Naples fauna, while the Ithaca fauna makes its appearance 520 feet above the base of the Jennings, and ranges up to the beds containing *Camarotœchia congregata* var. *parkheadensis*. The *Liorhynchus globuliforme zone* contains a profusion of fossils, rendering this one of the best localities in the State for collecting Ithaca fossils.

VIII. Section on National Road West of Tonoloway Ridge[1]

This section is situated five and one-half miles northeast of the preceding and its lower part embraces the same strata. It is exposed along the National Road, beginning at the Romney-Jennings contact about one mile west of the Tonoloway Ridge, and extending westward 4002 feet. The upper strata are not well exposed, the section being important chiefly because it affords a good exposure of the lower Jennings.

JENNINGS FORMATION *Chemung Sandstone Member* Road N. 35° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Largely concealed. Fossils at top	4002	143	3692
Road leading south. Approximate position of upper conglomerate of Chemung	3882		3549
Red shale	3822	67.5	3549
Red sandstone	3752	7	3481
Red shale. Beds of red sandstone. Some green shale	3745	135	3474
Red shale breaking irregularly	3605	14.5	3339
Red and green sandstone	3590	29	3325
Red shale breaking irregularly	3560	38.5	3296
Concealed	3520	38.5	3257

[1] Measured by pacing. Thickness calculated using average strike N. 24° E., average dip 79° W.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Church	3480		3219
Concealed	3480	87	3219
Second-class road leading north	3390		3132
Concealed	3390	183	3132
Concealed. At the top occurs *Spirifer mesastrialis*	3200	173.5	2949
Concealed. At the top of this unit on hillside were found *Spirifer disjunctus* and *S. mesastrialis*	3020	58	2775
Concealed. At top of this unit were found *Spirifer disjunctus* and *S. mesastrialis* in fragments on north side of road *Spirifer* (*Delthyris*) *mesacostalis*	2960	337	2717
Green shale breaking irregularly. Thin beds of flaggy sandstone	2610	96.5	2284
Concealed. At 2460 (2235 vertically) second-class road leading west	2510	96.5	2284
Fissile green shale and some shale breaking irregularly. A bed of massive green sandstone at top 5 to 7 feet thick	2410	135	2187
Fissile green shale. Dip 76° W. Crinoid segments at top	2270	48	2052

Parkhead Sandstone Member. (Upper Limit Approximate)

Concealed	2220	48	2004
Fissile green shale	2170	48	1956
Concealed	2120	48	1908
Fissile green shale with beds of flaggy sandstone	2070	193	1860
Concealed. School house north side of road	1870	53	1667
Green shale breaking irregularly. N. 37° E. 82° W.	1850	29	1614
Green splintery shale breaking irregularly with beds of flaggy sandstone. A massive sandstone at 1765 (1563 vertically)	1785	164	1585
Brown conglomeratic sandstone containing *Camarotœchia congregata* var. *parkheadensis* abundant, *Tropidoleptus carinatus*, *Spirifer* (*Delthyris*) *mesacostalis*. N. 28° E. 80° W.	1615	7	1421
Red shale with beds of flaggy red and green sandstone	1608	19	1414
Massive green sandstone	1588	11.5	1395
Fissile green shale	1576	9.5	1384
Massive green conglomeratic sandstone	1566	7	1374

Woodmont Shale Member

BEDS CONTAINING ITHACA FAUNA

Olive-green shale breaking irregularly at bottom, fissile at top. A sandstone at 1495 horizontally (1303 vertically). N. 35° E. 70° W.	1559	106	1367

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Splintery olive-green shale breaking irregularly. A very small fold	1449	43	1261
Largely concealed with hackley and splintery green shale	1404	57.5	1218
Fissile green shale. Some bands green sandstone	1344	57.5	1161
Brownish-red sandstone	1284	7	1103
Fold. Omitted in measurement	1277		
Brownish-red sandstone	1267	9.5	1096
Brown shale breaking irregularly	1257	19	1087
Brown shale breaking irregularly, somewhat folded	1237	29	1068
Fissile green shale and beds of flaggy brownish-green sandstone. At 1195 horizontally (1029 vertically) occur *Productella speciosa*, *Spirifer mucronatus* var. *posterus*	1207	38.5	1039
Green sandstone and shale. Omitted on account of folding. At 1115 horizontally (1038 vertically) occur *Cyrtina hamiltonensis*, *Liorhynchus globuliforme* abundant, *Productella speciosa* abundant, *Pugnax pugnus* var. *altus*, *Spirifer mucronatus* var. *posterus*	1167		
Green flaggy sandstone and fissile green shale	1087	14.5	1001
Green shale breaking irregularly. At 1065 horizontally (980 vertically) occur *Productella speciosa*, *Pugnax pugnus* var. *altus*, *Spirifer mucronatus* var. *posterus*	1072	38.5	987
Hackly shale, omitted in calculation on account of folding	1032		
Hackly and fissile olive-green shale with beds of green sandstone. Dip 78° W	1012	38.5	948
Brownish-green sandstone	972	7	910
Brownish-green fissile shale	965	67.5	903
Fold. Omitted in calculation	895	5	
Fissile green shale	885	5	835
Fold. Omitted in calculation	880		
Green fissile shale with bands of green sandstone. Some shale breaking irregularly. Slight overturn. Dip 100° W. at bottom, 90° W. of top	860	187	830
BEDS CONTAINING NAPLES FAUNA			
Green fissile shale, some flaggy sandstone. Dip 77° W.	670	443	643
Road N. 90° E.			
Green fissile shale. *Buchiola speciosa* fauna. Dip 80° W	210	200	200
Romney-Jennings contact	0		0

ROMNEY FORMATION

Massive sandstone. N. 25° E. 55° W.

The *Liorhynchus globuliforme zone* of the Ithaca fauna is well exposed and is overlain by a conglomerate containing *Camarotœchia congregata* var. *parkheadensis* in profusion. The strata are evidently the same as those seen at Tonoloway. The occurrence of the *Liorhynchus mesacostale zone,* shown by the presence of *Leptodesma naviforme* at the base of the Parkhead, is of interest as it can be traced westward in a similar position as far as Allegany Grove.

IX. Section Near Mann, Pennsylvania[1]

This section is exposed along the road leading northwest from Little Tonoloway Creek near the Pennsylvania-Maryland State line through Mann, to Black Oak Ridge in Bethel Township, Fulton County, Pa. While the lower strata are largely concealed, the section is of importance because it extends from the base of the Jennings to the Catskill and permits an estimate of the thickness of the Jennings in this area.

CATSKILL FORMATION

Red sandstone and shale.

JENNINGS FORMATION *Chemung Sandstone Member* Road S. 25° E	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Jennings-Catskill contact	5280		4391
Fissile argillaceous greenish-yellow shale and some speckled red sandstone	5280	27.8	4391
Reddish-brown somewhat hackly shale	5240	10.4	4363
Thin-bedded grayish-brown sandstone	5225	8.3	4353
Argillaceous yellowish-green sandstone and shale	5213	13.9	4344
Road S. 90° E.			
Splintery red shale breaking irregularly, some green splintery shale	5193	46.4	4330
Yellow-green sandstone	5143	1	4285
Interbedded yellowish-green and red argillaceous shale, some thin beds greenish-yellow sandstone. A heavier bed of yellowish-green sandstone at bottom	5142	46.4	4284

[1] Measured by pacing.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Road N. 60° E.			
Variegated red and greenish-yellow shale, some sandstone	5092	69.9	4238
Thin-bedded argillaceous yellowish-green sandstone, one bed reddish-brown sandstone near bottom	4982	44.5	4168
Road N. 80° E.			
Thin-bedded agillaceous yellow and green sandstone	4912	77	4123
Road N. 55° E.			
Yellowish-green argillaceous sandstone. Heavy-bedded at top. Thin-bedded at bottom	4822	17	4046
Yellowish-green shale breaking irregularly at top. Reddish-brown and yellowish-green shale interbedded below. Dip 85° W	4792	22.8	4029
Yellowish-green argillaceous sandstone and shale	4752	11.4	4006
Road N. 25 E.			
Yellowish-green argillaceous sandstone and shale	4732	1.6	3995
Reddish-brown and yellowish-green argillaceous shale	4712	2.4	3994
Reddish-brown argillaceous sandstone thin-bedded. Some interbedded shale of same color	4682	3.2	3991
Mostly concealed. Some yellowish-green argillaceous shale	4642	11.2	3988
Road N. 15 E.			
Reddish-brown sandstone, thin-bedded. Dip 80° W	4512	2.5	3977
Yellowish-green and reddish-brown interbedded arenaceous shale, breaking somewhat irregularly	4482	8.5	3974
Road N. 55° E.			
Yellowish-green and reddish-brown interbedded arenaceous shale, somewhat hackly, partially concealed	4372	39.4	3966
Road S. 50° E.			
Fork in road	4312		3926
Concealed	4312	92.5	3926
Road S. 30° E.			
Concealed	4212	98	3840

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Road S. 15° E.			
Concealed	4022	84.8	3736
Road S. 70° E.			
Concealed	3932	9.8	3651
Run	3922		3641
Concealed	3922	78	3641
Road south	3842		3563
Concealed	3842	147	3563
Log road to north upon which a section is measured, given at the end of this section	3692		3416
Poorly exposed, greenish-yellow argillaceous shale	3692	88.6	3416
Poorly exposed yellowish-green shale weathering reddish-brown	3602	246.2	3327
Road S. 65° E.			
Log road to north	3352		3081
Green and reddish-brown arenaceous shale, some thin beds reddish-brown sandstone	3352	107.8	3081
Road S. 55° E.			
Concealed. Dip 75° W	3242	167.8	2973
Road S. 65° E.			
Massive conglomerate sandstone bearing *Camarotœchia eximia*, *Tropidoleptus carinatus*, fragments seen on hillside to the north. Lower Chemung conglomerate	3062		2805
Concealed	3062	38.4	2805
Yellowish-green argillaceous shale, poorly exposed. Fragments of green sandstone on surface	3022	48	2767
Reddish-brown arenaceous shale, some green arenaceous shale	2972	115.2	2719
Road S. 73° E.			
Brown arenaceous shale interbedded brown sandstone. Dip 85° W	2852	29.7	2604
Green arenaceous shale, some brown arenaceous shale	2822	99	2574
Brown conglomerate on hill	2802		2554
Road S. 80° E.			
Green arenaceous shale	2722	117.7	2475
Brown arenaceous shale, some green shale. Green sandstone at bottom	2602	98.1	2357

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Road S. 50° E.			
Road leading north	2502		
Green and brown interbedded arenaceous shale	2502	94	2259
Road S. 55° E.			
Brown arenaceous somewhat hackly shale	2402	21.2	2165
Green arenceous shale becoming more argillaceous towards bottom. Some brown shale and beds of green sandstone, mostly concealed, green sandstone at 2210 horizontally (1980 vertically) and 2060 horizontally (1835 vertically)	2380	357.4	2144
Parkhead Sandstone Member. (Upper Limit Approximate)			
Road to the southwest	2010		1787
Brown sandstone at top, green sandstone at bottom, not well exposed	2010	48.3	1787
Massive sandstone bearing *Camarotœchia congregata* var. *parkheadensis* at top, forming hilltop	1990		1767
Road S. 70° E.			
Green arenaceous shale mostly concealed	1960	140	1738
Prominent thick green thin-bedded sandstone bearing *Camarotœchia congregata* var. *parkheadensis*. N. 20° E. 90° W	1820	15	1598
Mostly concealed, some green arenaceous shale	1805	40	1583
Road S. 75° E.			
Fissile green shale	1765	44.8	1543
Mostly concealed, probably green shale in part	1720	79.8	1499
Woodmont Shale Member			
BEDS CONTAINING ITHACA FAUNA			
Brown hackly shale	1640	9.9	1419
Concealed	1630	19.9	1409
Brown sandstone	1610	4.9	1389
Brown and green shale, weathering to irregular fragments	1605	34.8	1384
Thin-bedded brown sandstone. Dip 80° W	1570	9.7	1349
Thin-bedded brown sandstone and brown arenaceous shale	1560	19.4	1340

Road S. 85° E.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Yellowish-green arenaceous shale	1540	28.4	1320
Concealed	1510	142.7	1292
Road N. 85° E.			
Concealed	1360	62.4	1149
Road N. 65° E.			
Turn of road	1290		
Concealed. House and store in interval	1290	125.2	1087
Road N. 60° E.			
Concealed	1110	63.3	962
Arenaceous green shale	1010	44.3	898
Road N. 85° E.			
Green argillaceous shale partially concealed	940	89.2	854
Road S. 80° E.			
Concealed	840	194	765
BEDS CONTAINING NAPLES FAUNA			
Road N. 85° E.			
Concealed	640	365.8	571
Run	230		205
Concealed	230	142.7	205
Olive-green shale	70	62.4	62.4
Romney-Jennings contact	0		0

ROMNEY FORMATION

Massive sandstone.

Section on Log Road beginning at 3692 horizontally (3415 vertically) of Mann Section

Road N. 71° W.			
Reddish-brown sandstone containing *Spirifer mesastrialis*	3971	8.2	3641
Conglomerate and grayish-green sandstone. Upper Chemung conglomerate	3951	3.2	3633

Road N. 35° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Red and green hackly shale and some thin-bedded reddish-brown sandstone	3943	86.9	3629
Gray and reddish-brown thin-bedded sandstone	3833	7.9	3543
Road N. 50° W.			
Red and green shale breaking irregularly	3822	27.6	3535
Brown sandstone, medium-bedded, some red and green shale breaking irregularly	3792	27.6	3507
Brown arenaceous somewhat hackly shale	3762	13.8	3479
Numerous thin-bedded green shale breaking irregularly. Interbedded grayish-green sandstone. Dip 80° W	3747	27.6	3466
Yellowish-green and reddish-brown arenaceous shale. Dip 80° W	3717	23.1	3438
Joins main section on County road	3692		3415

An interesting feature of the section is the recurrence of the *Tropidoleptus* fauna in the lower Chemung conglomerate, 600 feet above the base of the Chemung member. This fact is of imporance stratigraphically because it permits the correlation upon faunal grounds of this conglomerate with a similar stratum west of Sideling Hill Creek.

The Jennings formation outcrops in the anticlinal area between Sideling Hill and Town Hill, at the southwestern extremity of which Pawpaw, West Virginia, is situated. The Potomac River meanders in this district in great bends, affording admirable sections. Those described are considered in the order of their location from northeast to southwest.

X. Section on Sideling Hill Creek

A short section is exposed on the west bank of Sideling Hill Creek, two and one-half miles above its mouth, and one mile down the stream from the home of Mr. Stottelmeyer. The horizon is probably the upper conglomerate of the Parkhead member and is situated approximately 1700 feet above the base of the Jennings as shown by other sections in the area. The following fossils were found at this place: *Atrypa reti-*

cularis, Camarotœchia congregata var. *parkheadensis* abundant, *Camarotœchia horsfordi, Cyrtina hamiltonensis* common, *Productella lachrymosa* abundant, *Spirifer marcyi* var. *superstes* common, *Spirifer (Delthyris) mesacostalis* abundant, *Tropidoleptus carinatus* abundant, *Cypricardella gregaria* var. abundant, *Cypricardella tenuistriata, Goniophora hamiltonensis, Goniophora truncata, Schizodus* sp., *Bellerophon clarki, Bucanopsis mæra* common, *Cyclonema concinnum, Cyclonemina multistriata* abundant, *Ectomaria marylandica, Holopea* sp., *Hormatoma bistriata, Loxonema ? glabrum Orthonychia unguiculata, Phœnerotinus laxus, Pleurotomaria (Gyroma) capillaria, Straparollus marylandicus, Orthoceras* sp., *Phacops rana.*

While the section is very short it is remarkable for the profusion and perfect preservation of the fossils contained in it. Probably no other locality in the State has afforded so many species from a single bed of the Jennings formation.

XI. Section on Fifteenmile Creek [1]

Fifteenmile Creek crosses the axis of the Pawpaw anticline one mile north of Little Orleans, where the following section is exposed.

JENNINGS FORMATION *Chemung Sandstone Member* Direction of creek due N. S.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green fissile shale with bands of green sandstone. At top occur *Schuchertella chemungensis, Spirifer disjunctus, S. mesastrialis.* N. 25° 40° E.	1405	70	2286
Direction of creek N. 53° E.			
Green fissile shale with considerable thick-bedded massive green sandstone. At top a layer of fossils occurs 4 inches thick containing crinoid segments, *Ambocœlia umbonata* abundant, *Chonetes scitulus, Pterinea chemungensis, Spirifer disjunctus*	1185	167	2216

[1] Measured by pacing.

Parkhead Sandstone Member	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Fissile green shale and bands of interbedded sandstone. Minor folding occurs in this unit	935	74	2049
Same as above with minor folding N. 25° E. 42° E.......	825	201	1975
Green shale and interbedded sandstone. At top occur *Camarotœchia congregata* var. *parkheadensis* abundant, *Spirifer* (*Delthyris*) *mesacostalis*, *Tropidoleptus carinatus*, *Cyclonemina multistriata*, *Loxomena* ? *glabrum*. N. 25° E. 45° E..	525	7	1774
Fissile green shale and bands of interbedded green sandstone. A fossiliferous layer, 6 inches thick at top, contains *Camarotœchia congregata* var. *parkheadensis* abundant, *Spirifer* (*Delthyris*) *mesacostalis* common..........	515	20	1767
Fissile green shale and bands of green sandstone. At the top in a band of green sandstone were found *Camarotœchia congregata* var. *parkheadensis* abundant, *Spirifer* (*Delthyris*) *mesacostalis*, *Tropidoleptus carinatus* abundant, *Coleolus tenuicinctus*, *Cyclonemina multistriata*. N. 21° E. 42° E..	485	33	1747
Fissile green shale with bands of hard green sandstone. Near top of this unit a conglomerate occurs about 6 inches in thickness. N. 25° E. 55° E. At top occur *Camarotœchia congregata* var. *parkheadensis*, *Tropidoleptus carinatus*, *Cyclonemina multistriata* in tough green shale. At the bottom is a conglomerate containing *Camarotœchia congregata* var. *parkheadensis* abundant	435	164	1714

Woodmont Shale Member

BEDS CONTAINING ITHACA FAUNA

Fissile green shale with bands of green sandstone. N. 13° E. 42° E..	235	104	1556
Green fissile shale with bands of sandstone. N. 13° E. 40° E. At the top occur *Crytina hamiltonensis* abundant, *Liorhynchus globuliforme*, *Orbiculoidea* cf. *media* ?, *Productella speciosa*, *Pugnax pugnus* var. *altus*, *Spirifer mucronatus* var. *posterus*, *Stropheodonta demissa*, *Ectenodesma birostratum*, *Pterinea chemungensis*	75	46	1446
Base of section	0		1400
Remainder of section is concealed.			

No reduction in estimates of thickness is made for minor folding in the units in upper part of Parkhead member in above section, hence their thickness is somewhat too large.

The *Liorhynchus globuliforme zone* of the Ithaca fauna is well exposed, occupying its normal position below the Parkhead member.

XII. Section near Little Orleans [1]

There is an excellent exposure of the Jennings in the cuts of the Western Maryland Railroad and in the banks of the C. and O. Canal east of Little Orleans. The section extends from the top of the Woodmont shale member to the base of the Catskill. The strata of the upper beds containing the Ithaca fauna are exposed on the railroad but no fossils were observed in them. Ithaca fossils were found, however, along the wagon road that ascends the hill from the railroad station, just north of the railroad tracks.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
CATSKILL FORMATION			
Canal. S. 60° E.			
Canal lock	5958		
Concealed	5958		
Ravine	5556.3		
Brown sandstone with some green sandstone	5556.3		
Brown shale breaking irregularly with an occasional bed of brown sandstone	5523.3		
JENNINGS FORMATION			
Chemung Sandstone Member			
Jennings-Catskill contact	5213		4548
Green sandstone	5213	14.4	4548
Brown sandstone	5197.3	12.6	4533
Thin-bedded green sandstone with some beds of massive green sandstone	5183.3	46.2	4521
Brown and green shale breaking irregularly	5132.3	25.3	4475
Thin-bedded brown sandstone	5104.3	23.5	4449
Thin-bedded brown sandstone with interbedded brown and green shale breaking irregularly	5078.3	47.1	4426
Heavy-bedded brown sandstone with interbedded thick beds of brown sandstone N. 30° E. 65° E	5026.3	51.6	4379
Thin-bedded green sandstone	4969.3	14.8	4327
Reddish-brown sandstone with occasional hackly beds of brown shale. N. 30° E. 45° E	4948.3	25.8	4312

[1] Measured by tape.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Brown hackly shale predominating with gray and brown interbedded sandstone	4911.3	86.5	4287
Thin-bedded green sandstone with interbedded green shale	4798.8	22.2	4200
Heavy-bedded brown sandstone with an occasional bed of green sandstone N. 30° E. 50° E	4769.8	48.2	4178
Massive gray sandstone	4706.8	17.2	4130
Brilliant red band of flaggy sandstone at the bottom and red shale breaking irregularly at the top	4687.3	18.5	4113
Interbedded hackly brown and green shale with thin beds of flaggy grayish-green sandstone	4666.2	27.2	4094
Brown sandstone, heavy-bedded at the bottom, thin-bedded towards the top. N. 30° E. 62° E	4635.2	11.4	4067
Gray sandstone lower 10 feet massive, upper 30 feet thin-bedded	4622.2	35.2	4055
Interbedded green and brown shale breaking irregularly	4582.2	36.1	4020
Brown and green shale breaking irregularly with some interbedded brown sandstone	4541.2	13.2	3984
Brilliant red hackly shale	4526.2	12.3	3971
Green and brown shale breaking irregularly with interbedded grayish-green and some brown sandstone	4512.3	125	3959
Brown sandstone	4370.2	2.6	3833
Brown shale breaking irregularly. Strike N. 30° E.	4367.2	5.2	3833
Thin-bedded gray flaggy sandstone	4361.2	63.7	3826
Brown hackly shale at the bottom with thin beds of green hackly shale in middle of unit and gray sandstone at top. N. 27° E. 62° E	4288.6	36.8	3762
Green and reddish-brown arenaceous shale with thin bed of gray sandstone at top	4246.8	11.1	3725
Massive brown sandstone	4233.6	6.8	3714
Hackly green arenaceous shale with an occasional thin bed of grayish-green sandstone	4225.6	9.4	3707
Hackly interbedded brown and green arenaceous shale interbedded with grayish-green sandstone and some brown sandstone. N. 25° E. 60° E	4214.6	81.5	3698
Grayish-brown shale breaking irregularly	4120	7.9	3616
Brown sandstone with interbedded brown shale breaking irregularly	4111	7	3608
Red and green shale breaking irregularly with interbedded thin and heavy beds of brown and grayish-green sandstone. Dip 62° E	4103	65.2	3601
Heavy and thin-bedded gray sandstone coarse-grained and carrying small pebbles. N. 30° E. 55° E	4029	12.2	3536

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Gray arenaceous shale breaking irregularly	4014	10.3	3524
Massive brown sandstone with some interbedded brown shale	4001.6	8.1	3514
Massive reddish-brown sandstone	3991.6	6.5	3506
Grayish-brown shale breaking irregularly	3983.6	28.8	3499
Brownish red sandstone at the bottom, overlain by gray sandstone. At the top a bed of fossils 1 foot thick containing *Spirifer disjunctus*, gastropods, crinoids	3948.6	10.6	3470
Reddish-brown and green shale with occasional bed of thin-bedded sandstone	3935.6	8.1	3459
Brown and green hackly shale, brown shale at bottom, green shale at top. N. 30° E. 65° E	3925.6	10.6	3452
Massive brown sandstone	3912.6	4	3441
Green arenaceous shale with occasional interbedded grayish-green sandstone	3907.6	6.2	3437
Conglomeratic sandstone 9 inches of conglomerate at top	3900	12.2	3431
Green shale breaking irregularly	3885	3.6	3418
Heavy beds of grayish-green coarse-grained sandstone with some interbedded green shale	3880.9	10.5	3415
Arenaceous green shale with very thin beds of green sandstone at the top. N. 30° E. 55° E	3868	9	3405
Thin and heavy-bedded interbedded grayish-green fine-grained sandstone	3857	37.7	3396
Grayish-green arenaceous shale	3816	15.6	3358
Gray sandstone, thin-bedded to about six inches thick, sandstone near the middle almost coarse-grained conglomeratic	3799	9.2	3342
Olive-green, somewhat fissile shale with occasional beds of sandstone. N. 30° E. 67° W	3789	65.3	3333
Partly concealed. Mostly thin-bedded olive-green shale weathering brown with some interbedded gray sandstones not more than 6 inches thick. N. 31° E. 65° E	3718	75.1	3268
Grayish-green sandstone	3635	0.8	3193
Grayish-brown arenaceous shale with thin beds of gray sandstone	3634	43.3	3192
Heavy brown sandstone	3583.1	2.2	3149
Olive-green shale with interbedded thin beds of flaggy green sandstone. N. 30° E. 60° E	3581.4	38.9	3146
Fissile green shale with some brown fissile shale	3536.4	26.2	3107
Gray flaggy sandstone with some interbedded green shale	3507.4	7.2	3081
Olive-green arenaceous shale with some thin beds of gray sandstone at the bottom. N. 30° E. 65° E	3499.4	44.9	3074

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Reddish-brown hackly shale	3249.8	1.7	3029
Fine-grained grayish-green thin-bedded sandstone with some interbedded olive-green shale. N. 25° E. 60° E.	3248	21.5	3027
Canal S. 85° E.			
Arenaceous fissile olive-green shale with a bed of brown sandstone 6 inches thick at the bottom. Occasionally beds of grayish-green sandstone	3223	50	3006
Olive-green arenaceous shale with thin beds of grayish-green sandstone	3160	34.2	2956
Grayish-green sandstone	3117	0.9	2922
Olive-green shale with some thin beds of grayish-green sandstone near the middle. N. 28° E. 60° E.	3016.2	87.6	2921
Olive-green shale breaking irregularly. N. 30° E. 60° E.	3006.2	121.8	2833
Conglomeratic grayish-brown sandstone, coarse-grained sandstone with pebbles the size of a pea scattered throughout. N. 20° E. 63° E.	2853.6	1.6	2711
Grayish-green arenaceous shale	2851.6	9.1	2710
Thin and heavy-bedded gray sandstone	2840.7	14.8	2701
Reddish-brown arenaceous shale	2819.7	1.3	2686
Grayish-green arenaceous shale	2817.7	7	2685
Heavy-bedded gray sandstone. N. 27° E. 50° E.	2807.7	18.4	2677
Grayish-green arenaceous shale breaking irregularly with some interbedded thin beds of flaggy sandstone	2781	21.9	2659
Brown and gray flaggy sandstone with some interbedded hackly brown shale at the bottom and grayish-green shale at top	2753.7	7.7	2637
Grayish-green hackly arenaceous shale with a bed of brown sandstone at the bottom 1 foot and 9 inches thick and some interbedded gray sandstone. N. 30° E. 60° E.	2743.7	9.2	2630
Grayish-brown arenaceous shale breaking irregularly	2731.8	11.6	2620
Grayish-brown arenaceous shale breaking irregularly	2716.8	26.6	26.09
Heavy-bedded brown sandstone. N. 30° E. 60° E.	2682.8	10.1	2582
Hackly grayish-brown arenaceous shale with a bed of brown sandstone at the top	2669.8	5	2572
Grayish brown arenaceous shale. N. 25° E. 65° E.	2663.8	13.5	2567
Brown hackly arenaceous shale N. 30° E. 50° E.	2657.8	21.4	2553
Heavy-bedded gray sandstone with some little grayish-green fissile shale	2626.8	19.9	2532
Arenaceous grayish-green shale with interbedded gray sandstone. A bed of brown sandstone 10 inches thick at top. N. 30° E. 55° E.	2599.8	105.1	2512

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Thin-bedded arenaceous grayish shale with interbedded gray flaggy sandstone	2471.8	79.7	2407
Heavy bed of gray sandstone	2373.8	2.5	2328
Grayish-green arenaceous shale with interbedded gray sandstone	2370.8	26.3	2305
Thin-bedded gray arenaceous shale with interbedded gray flaggy sandstone, N. 25° E. 65° E.	2339.8	48.4	2299
Thin-bedded grayish-green arenaceous shale with interbedded gray flaggy sandstone. Dip 80° E.	2282.8	8.5	2250
Arenaceous grayish-brown shale with occasional bed of thin fine-grained gray sandstone. N. 19° E. 65° E.	2273.8	54.3	2242
Thin-bedded arenaceous grayish-brown shale with some interbedded sandstone 6 inches in thickness. N. 20° E. 55° E.	2212	52	2188
Somewhat hackly thin-bedded arenaceous grayish-brown shale with occasional thin bed of sandstone. N. 30° E. 60° E.	2147	9.1	2136
Gray sandstone with a thin band of interbedded green shale	2134	4.1	2126
Thin-bedded green shales with interbedded gray flaggy sandstone	2129	44.6	2122
Thin-bedded green shale with interbedded gray flaggy sandstone. N. 18° E. 60° E.	2076	60.7	2078
Thin-bedded grayish-green somewhat fissile arenaceous shale with some beds of gray flaggy sandstone 6 inches thick. N. 20° E. 55° E.	2004	18.1	2017
Parkhead Sandstone Member			
Sharp fold. Eliminated in measuring vertical thickness.	1980		
Thin-bedded grayish-green shale. Dip 70° E.	1971	20.3	1999
Heavy-bedded gray sandstone	1947	1	1979
Grayish-green thin-bedded shale. N. 30° E. 72° E.	1946	18.9	1978
Canal S. 77° E.			
Arenaceous grayish-green thin-bedded shale somewhat fissile. N. 27° E. 70° E.	1924	19	1955
Sharp anticlinal folds. Slickensides	1903		
This 90 feet to be eliminated in adding the vertical thickness of section due to minor fold. Dip to W.	1903		

Canal S. 60° E.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
West end of tunnel	1835		1941
Center of syncline. Minor folds	1813		
Somewhat hackly thin-bedded grayish-green arenaceous shale weathering brown	1813	7.6	1940
Thin-bedded arenaceous grayish-green shale with occasional thin beds of sandstone. A bed of sandstone 10 inches at top. N. 30° E. 50° E	1803	22.4	1932
Canal S. 20° E.			
Gray shale breaking irregularly with some occasional thin beds of gray sandstone. N. 30° E. 45° E	1775	28.9	1910
Remainder of Section on Western Maryland Railroad.			
Railroad N. 60° E.			
Chiefly concealed. Arenaceous shale and interbedded sandstone in part	1725	120.1	1881
Bluish-green sandstone	1504	7.4	1761
Heavy bluish-green sandstone. A zone of fossils at top containing *Spirifer* (*Delthyris*) *mesacostalis*, *Tropidoleptus carinatus* abundant, *Coleolus tenuicinctus* abundant, *Bucanopsis mæra* abundant, *Bellerphon clarki*, *Cyclonemina multistriata* common, *Loxonema* ? *glabrum* abundant	1495	1.6	1753
Shale	1493	9	1752
Shale. Small zone fossils at top containing *Spirifer* (*Delthyris*) *mesacostalis*, etc	1482	9.8	1743
Railroad N. 80° E.			
Chiefly shale	1470	24.6	1733
Massive sandstone with 6 inches of conglomerate at base containing a few white pebbles. The conglomerate very fossiliferous containing *Camarotœchia congregata* var. *parkheadensis*, *Spirifer* (*Delthyris*) *mesacostalis*, *Tropidoleptus carinatus*, gastropoda, etc	1435	4.7	1708
Chiefly shale. Some sandstone	1429	34.7	1704
Shale and sandstone. At top is a six-inch conglomerate above which are 2 feet of shale, 18 inches of sandstone, 10 inches of shale and 1 foot of sandstone	1385	61.3	1669
Concealed in part. A band of fossils 4 inches thick at top, underlain by 8 inches shale and 9 inches sandstone, containing *Camarotœchia congregata* var. *parkheadensis*, *Spirifer* (*Delthyris*) *mesacostalis*, etc	1301	12.5	1608

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Shale and some sandstone concealed in part. N. 21° E. 60° E.	1284	11.6	1595
Shale. A thin conglomerate at top	1268	10.6	1584
Top of nodular sandstone same as at 1110. N. 20° E. 35° E.	1253		1573
Sandstone, same as at 1110	1192		
Axis of syncline	1140		
Concealed. *Camarotœchia congregata* var. *parkheadensis* loose at top	1120		1581

Woodmont Shale Member

BEDS CONTAINING ITHACA FAUNA

Olive-green arenaceous shale, a nodular sandstone 4 feet thick at top	1110	32.2	1573

Railroad N. 80° E.

Olive-green arenaceous shale with some interbedded grayish-green sandstone. Dip 70° E.	1070	94.3	1541

Railroad N. 70° E.

Olive-green arenaceous shale with an occasional thin bed of flaggy grayish-green sandstone. N. 23° E. 52° E.	950	63.1	1445
Strata from 740 to 840 feet to be eliminated in adding the vertical thickness of this section on account of folding. Dip 58° W.	840		
Axis of minor syncline	740		
Thin-bedded olive-green shale with thin interbedded green sandstone. N. 33° E. 70° E.	740	22.5	1383
Olive-green shale with thin beds of grayish-green sandstone. N. 33° E. 53° E.	700	43.1	1361
Arenaceous olive-green shale with thin beds of green fine-grained sandstone and a heavy-bedded reddish-brown sandstone at bottom. N. 33° E. 48° E.	610	17.8	1318
Base of exposed section	570		1300

Railroad N. 65° E.

Concealed along railroad	570		
Beginning of section at axis of anticline	0	0	0

The Parkhead member is well exposed and abounds in fossils. They are especially profuse in the upper conglomeratic sandstone which is probably the same stratum as that exposed in the section described on Sideling Hill Creek.

The lower Chemung conglomerate, situated about 600 feet above the base of the Chemung, is exposed at many localities in the vicinity of Magnolia and Pawpaw. One of the more accessible localities is on the Baltimore and Ohio Railroad one and one-half miles west of Pawpaw. Wherever examined in the vicinity this conglomerate is found to contain *Tropidoleptus carinatus* associated with other recurrent Hamilton species.

XIII. Section on Western Maryland Railroad Two Miles West of Pawpaw[1]

A number of fine sections of parts of the Jennings formation are exposed in the cuts of the Western Maryland Railroad on the north bank of the Potomac River, west of Pawpaw. The more easterly of the exposures are so involved in minor folding that it has not proved possible to use them for the purpose of correlation. Approaching the Town Hill syncline the structure becomes more simple, where an almost uninterrupted section of the middle and the upper part of the Jennings was measured in the cuts of the Western Maryland Railroad two miles west of Pawpaw. The section begins at the center of a small ravine 3364 feet west of the western limits of the Pawpaw quadrangle and extends eastward 4662.5 feet to the center of a small anticline. This is the most complete section of the upper part of the Jennings seen in the State.

CATSKILL FORMATION	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Center of ravine	0		
Concealed	13	11	
Red sandstone. N. 25° E. 58° W.	80	56.9	

[1] Measured by tape.

JENNINGS FORMATION

Chemung Sandstone Member

Railroad N. 70° W.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Catskill-Jennings contact	80		4760
Green shaly sandstone and bands of red sandstone	130	42.5	4717
Red shaly sandstone. At the bottom occur *Camarotœchia eximia* common, *Spirifer disjunctus*, *Lepdodesma* sp., *Palæanatina augusta*	146	13.5	4703
Red and green shaly sandstone. Dip 43° W.	164	13	4691
Green shaly sandstone	184	13.5	4677
Red sandstone	224	27	4650
Red and green shale breaking irregularly. Dip 55° W. At bottom occurs *Camarotœchia eximia*	242	14.5	4636
Green sandstone	258	12	4624
Red sandstone, massive below, shaly above. A green sandstone containing plant remains and *Camarotœchia eximia*, *Schuchertella chemungensis* ?, *Spirifer disjunctus* abundant, at 330 horizontally (4570 vertically)	429	140	4484
Massive green sandstone. Dip 30° W.	459	15	4469
Red shaly sandstone	487	14	4455
Massive green sandstone	592	52.5	4402
Red shale breaking irregularly and interbedded sandstone. Dip 28° W.	701	51	4351
Ravine	701		
Red sandstone	741	19	4332
Omitted from section on account of minor fold. Dip 58° W.	909		
Red sandstone and shale. Base of red band of Catskill type. Dip 58° W.	1111	172	4160
Green sandstone	1193	69.5	4091
Red sandstone and shale. Dip 65° W.	1242	44.5	4046
Green sandstone	1306	57.9	3988
Red sandstone. Dip 71° W.	1353	43.5	3945

Railroad N. 75° W.

Red thin-bedded sandstone and red shale. Dip 74° W. Green sandstone at 1400 horizontally (3900 vertically) contains *Camarotœchia* sp., *Spirifer* (*Delthyris*) *mesacostalis*, *Leptodesma* sp.	1443	84.2	3860
Green shale. At the bottom occur *Camarotœchia eximia*, *C. eximia* var. ? (sinus deeper than usual)	1458	14.5	3846
Green shale breaking irregularly with bands of red. Dip 72° W.	1555	92.5	3753
Green shale breaking irregularly and brown flaggy sandstone	1635.5	76	1150

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green shale breaking irregularly. Dip 60° W.	1669.5	29	3648
Green sandstone	1701.5	27	3625
Green shale breaking irregularly and bands of sandstone. Dip 60° W.	1727.5	22	3699
Green sandstone	1736	7.6	3592
Green and red shale breaking irregularly	1796.5	51	3541
At 1797.5 in a green sandstone occur *Schuchertella chemungensis* common, and *Spirifer mesastrialis*			3540
Concealed	1872.5	58	3483
Ravine	1872.5		
Concealed	1898.5	22	3461
Coarse conglomerate. Dip 65° W. (Upper Chemung conglomerate)	1922.5	21	3440
Heavy sandstone at top grading into shale below	1943.5	19	3421
Concealed	1993.5	44.5	3376
Ravine	1993.5		
Green shale breaking irregularly and interbedded sandstone. Dip 78° W. Ten feet from bottom occur *Camarotœchia orbicularis*, *Spirifer* (*Delthyris*) *mesacostalis*	2072	74.5	3302
Fine-grained conglomerate	2073.5	1.4	3300
Green shale breaking irregularly. Dip 80° W.	2126.5	51.2	3249
Heavy brown sandstone	2128.5	2	3247
Green shale breaking irregularly	2130.5	2	3245
Conglomeratic sandstone	2133.5	2.8	3242
Shaly sandstone	2136.5	2.8	3240
Massive green sandstone	2139.5	2.8	3237
Green shale	2140.5	1	3236
Massive green sandstone	2142	1.4	3234
Green shale breaking irregularly. Dip 71° W.	2192	46.5	3188
Fissile green shale. Dip 71° W.	2262	64	3124
Coarse conglomerate	2263	1	3123
Green shale breaking irregularly	2329	61.4	3062
Railroad N. 80° W.			
Concealed	2679	319.5	2742
Small ravine	2679		
Concealed. Dip 75° W.	2717	35.4	2707
Olive-green fissile shale	2804	81.1	2626
Green shale breaking irregularly and concretionary sandstone	2836	28.8	2597
Coarse conglomerate. Dip 75° W. (Lower Chemung conglomerate)	2837	0.8	2596
Green sandstone with some shaly portions	2869	28.8	2567

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green shale breaking irregularly	2881	11.1	2556
Massive green sandstone	2896	13.9	2542
Green shale breaking irregularly	2925	27	2515
Concealed	2961	33.5	2482
Ravine	2961		
Fissile green shale. Dip 75° W	3055	87.7	2394
Green shale breaking irregularly	3081	24.4	2370
Fissile green shale	3120	36.3	2333
Smooth and hackly olive-green shale	3146	24.4	2309
Fissile brown shale	3166	18.6	2290
Fissile green shale	3201	32.5	2258
Green shale breaking irregularly and interbedded sandstone. Dip 75° W	3218	15.8	2242
Green argillaceous shale, carrying at bottom *Spirifer disjunctus*, *Spirifer* (*Delthyris*) *mesacostalis*, *S. mesastrialis*	3262	42	2200
Green shale breaking irregularly	3311	45.7	2154.3
Brown sandstone	3319	7.4	2147
Green shale breaking irregularly and bands of sandstone. Dip 68° W. Carrying at bottom *Spirifer disjunctus* abundant, *Cyclonemina multistriata*, *Loxonema styliolum* abundant, *Palæoneilo plana*	3344	22.5	2124
Parkhead Sandstone Member			
Limit of Flintstone-Pawpaw quadrangles	3364		
Green Shale	3435	81.7	2043
Concealed	3514	71	1972
Ravine	3514		
Green shale and flaggy sandstone. Dip 68° W	3565	45.8	1926
Green shale and shaly sandstone	3620	49	1877
Hackly green shale and sandstone	3696	73.5	1803
Shaly sandstone carrying at the bottom *Atrypa reticularis*, *Camarotœchia congregata* var. *parkheadensis*, *Productella lachrymosa*, *Spirifer marcyi* var. *superstes* abundant, *S.* (*Delthyris*) *mesacostalis* common, *Tropidoleptus carinatus* common, *Coleolus tenuicinctus*, *Loxonema styliolum*	3706	8.9	1794
Railroad N. 85° W.			
Green shale	3735	25.5	1769
Massive sandstone carrying at bottom *Ambocœlia umbonata*, *Schizodus oherni*, *Bucanopsis mæra*, *Platyceras marylandicum* ?, *Cypricardella gregaria* var., *Palæoneilo brevis* common	3742	6.1	1763

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green shale and shaly sandstone	3764	19	1644
Massive bluish and greenish sandstone	3774	8.7	1635
Green shale and interbedded sandstone	3790	14	1621
Green shale and bands of sandstone. Dip 70° W. Carrying at the bottom *Camarotœchia congregata* var. *parkheadensis* abundant, *Spirifer* (*Delthyris*) *mesacostalis*, *S. mucronatus* var. *posterus* ?	3914	109.5	1612
Green shale breaking irregularly	3928	12.3	1599
Massive brown sandstone. Dip 77° W. carrying at bottom *Camarotœchia congregata* var. with deeper sinus suggesting *contracta* abundant, *C. eximia*, *Coleolus tenuicinctus*, *Bellerphon clarki*, *Cyclonema concinnum*, *Cyclonemina multistriata* ?, *Loxonema* ? *glabrum* common, *Ectomaria marylandica*, *Pleurotomaria* (*Gyroma*) *capillaria* common, *Liopteria bigsbyi*. This sandstone weathers to a light yellow	3935.5	6.8	1597
Fissile green shale	3994.5	5.4	1539
Heavy dark-brown sandstone	3996.5	1.8	1537
Dark shale breaking irregularly	4022.5	23.7	1513
Coarse shale breaking irregularly, carrying at bottom *Camarotœchia congregata* var. *parkheadensis* abundant, *Chonetes deflectus*, *Goniophora hamiltonensis* common, *Grammysia elliptica*, *Palæoneilo brevis*, *Loxonema hamiltoniæ*	4053.5	28.5	1485

Woodmont Shale Member

BEDS CONTAINING ITHACA FAUNA

Green fissile shale. Dip 70° W. Carrying at bottom *Atrypa spinosa*, *Crytina hamiltonensis* common, *Liorhynchus globuliforme*, *Productella speciosa* abundant, *Pugnax pugnus* var. *altus* common, *Schizophoria striatula* abundant, *Stropheodonta demissa* ?, *Ectenodesma birostratum*, *Goniophora hamiltonensis*, *Palæoneilo brevis*	4162.5	96.3	1388
Green shale and bands of sandstone	4262.5	88.3	1300
Axis of small anticline	4662.5		1300
On east limb of anticline, 40 feet stratigraphically above axis, in a band of shaly sandstone were found *Cyrtina hamiltonensis* abundant, *Liorhynchus globuliforme* abundant, *Productella speciosa*, *Pugnax pugnus* var. *altus*, *Schizophoria striatula* abundant, very large and fine, *Spirifer mucronatus* var. *posterus* abundant, *Ectenodesma birostratum*	4662.5		1340

Base of section placed 1300 feet above top of Romney.

The *Liorhynchus globuliforme zone* of the Ithaca fauna is well exposed at this locality and abounds in fossils. Especially noteworthy are the abundance and size of *Schizophoria striatula* which is associated with *Spirifer mucronatus* var. *posterus*, and other diagnostic species of the Ithaca fauna.

The upper conglomerate of the Parkhead member contains a great profusion of fossils. A conspicuous feature is a red band of Catskill type that appears in the Chemung a considerable distance below the base of the Catskill and is overlain by sediments of Jennings type carrying marine fossils. The upper Chemung conglomerate is unusually thick and massive at this place.

A number of excellent sections of the Jennings are exposed on the west slope of Green Ridge, three of which will be described.

XIV. Section at Town Creek[1]

The section is seen in the cuts of the Western Maryland Railroad near the mouth of Town Creek, west of Town Creek station. It begins at the Romney-Jennings contact 6315 feet west of the west end of the bridge over Town Creek and extends eastward 7746 feet. This is the finest exposure of the entire Jennings observed in Maryland and was accordingly examined with unusual care.

CATSKILL FORMATION

Red sandstone and shale.

JENNINGS FORMATION *Chemung Member* Railroad N. 42° E.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Jennings-Catskill contact	**7746**		**4769**
Green and red shale. Dip 38° E. At top occur *Atrypa spinosa, Cryptonella* cf. *eudora, Douvillina cayuta, Schuchertella chemungensis, Schizophoria striatula* var. *marylandica, Spirifer disjunctus* abundant, *Holopea* ? sp., cf. *Grammysia undata*	**7746**	**53**	**4769**
Green and brown shale and bands of sandstone. At top occur *Camarotœchia eximia, Cryptonella* cf. *eudora* abundant, *Spirifer disjunctus* abundant, *Leptodesma* sp.	**7636**	**57.3**	**4716**

[1] Measured by tape.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green and brown sandstone. Dip 44° E. Carrying at top *Camarotœchia* sp.	7571	6	4659
Green shale	7508	22	4653
Green and red shale and shaly sandstone. At the top occur *Camarotœchia eximia*, *Leptostrophia perplana* var. *alternata*, *Spirifer disjunctus*, *Schizodus chemungensis* ?, *Leptodesma lichas*, *Schizodus oherni*, *Cypricardella* cf. *marylandica* small	7458	35	4631
Green shale and shaly sandstone. Ten feet from top occur *Spirifer disjunctus*, *Leptodesma* sp. ?, *Palæanatina angusta* abundant	7377	34	4596

Railroad N. 70° E.

Brown sandstone bearing at top *Spirifer disjunctus*	7304	9.5	4562
Red and green shale	7382	32.5	4552
Red sandstone	7207	7.7	4520
Red and green shale	7189	32.5	4512
Red shale and sandstone. Dip 42° E. At top occur *Schuchertella chemungensis*, *Spirifer disjunctus* abundant. From this point to 6500 the section was supplied from the hill north of the railroad near Mr. Kelly's house, measurements being parallel to dip	7014	60.5	4480
Red and green sandstone and some shale. Dip 45° E.	6875	58.3	4419
Coarse red shale	6748	35.3	4361
Concealed over old mill race	6663	15.8	4325
Massive red sandstone	6625	2.5	4310
Red shale and sandstone	6619	25.9	4307
Massive brown sandstone. Dip 40° E.	6578	23.8	4281
East end of railroad bridge	6500		
Concealed over bridge	6500	85	4257
West end of bridge	6315		
Concealed	6315	124.5	4172
Red Shale and sandstone. Dip 45° E.	6077	27.3	4048
Green sandstone	6027	7.1	4021
Red and green shale and shaly sandstone	6014	19.4	4014
Green shale breaking irregularly	6014	12	3994
Massive green and brown sandstone carrying *Camarotœchia eximia*, *Schuchertella chemungensis*, *Spirifer disjunctus* abundant, *Leptodesma* sp., *Palæoneilo* sp.	5992	13.1	3982
Green shale and concretionary sandstone. At top occur *Camarotœchia* sp., *Palæoneilo plana*, *Cypricardella* cf. *marylandica* small, *Grammysia elliptica*	5968	5.8	3969

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green and red shale breaking irregularly. At top occur *Camarotœchia eximia* abundant, *C. eximia* var. ? sinus deeper than usual, *Spirifer mesastrialis* small, *Grammysia elliptica*, *Leptodesma lichas*	5960	21.3	3963.3
Green and red shale and bands of sandstone. At top were found *Camarotœchia eximia* common, *Douvillina cayuta* rare, *Schuchertella chemungensis* abundant, *Schizophoria striatula* smaller than usual, common	5921	4.9	3942
Green and red shale breaking irregularly. Dip 47° E. At top were found *Camarotœchia eximia*, *Palæoneilo* sp.	5912	15.3	3937
Brown sandstone	5884	5.8	3922
Green hackly shale and concretionary sandstone, some bands of red	5875.5	31.5	3916

Railroad N. 75° E.

Green and red arenaceous shale. In yellow shaly sandstone at the top were found *Camarotœchia* sp.	5818	14.5	3884
Green shale breaking irregularly. At top occur *Camarotœchia eximia*, cf. *Grammysia undata*, *Leda diversa*, *Leptodesma* sp., *Paracyclas marylandica*, *Schizodus* resembles *oherni*, but very small, *Palæoneilo* sp. *Grammysia elliptica*.	5795	30.7	3870
Massive gray sandstone	5745	5	3840
Green shale breaking irregularly	5736.5	6.7	3835
Brown sandstone. Dip 47° E.	5725.5	1.8	3828
Green shale breaking irregularly. Some bands red	5722.5	17.8	3826
Brown sandstone	5693.5	3.4	3808

Railroad N. 80° E.

Green shale breaking irregularly and bands of sandstone. Irregular streaks of red shale	5688	45.4	3805
Green shale, breaking irregularly, and interbedded sandstone. At top occur *Orthoceras* cf. *demum*, *Leda diversa* ?, *Leptodesma lichas*, *Schizodus* resembles *oherni* but very small	5614	21	3760
Green shale breaking irregularly	5580	24.5	3739
Green shale breaking irregularly. At the top was found.	5541.5	6.5	3714
Red shale	5531	2.7	3708
Massive gray sandstone	5526.5	3.6	3705
Sandstone and interbedded green hackly shale	5520.5	12.8	3701
Sandstone and interbedded green hackly green shale	5490.5	5.5	3689
Gray sandstone	5490	1.2	3683
Red shale	5488.5	2.1	3682

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green shale breaking irregularly	5485	15.9	3680
Brown sandstone	5459	1.8	3664
Green shale breaking irregularly and bands of sandstone	5456	7.3	3662
Massive green sandstone	5444	6.7	3655
Railroad N. 85° E.			
Sandstone and green hackly shale	5433	34	3648
Red shale and sandstone	5381	7.8	3614
Sandstone and green shale breaking irregularly. Dip 48° E.	5369	10.7	3606
Red sandstone	5352	2.2	3596
Green sandstone carrying at top *Schuchertella chemungensis*, *Spirifer mesastrialis*, *Schizodus oherni*, *Palæonilo crassa* common	5349	4.5	3593
Red sandstone	5342	5.2	3589
Green shaly sandstone. At the top occur *Douvillina cayuta* rare, *Spirifer* (*Delthyris*) *mesascostalis*, *S. mesastrialis* ?, *Cypricardinia elegans* var. *angusta*, *Leptodesma lichas*, *Leptodesma* sp., *Palæoneilo crassa* abundant	5334	6	3584
Green shale breaking irregularly. A sandstone carrying at top *Cypricardinia elegans*, var. *angusta*, *Palæoneilo crassa* common	5325	13	3578
Red shale and sandstone	5305	7	3565
Green shale breaking irregularly	5294	31.2	3558
Massive brown sandstone and a little shale	5246	11	3526
Green shale breaking irregularly	5229.5	7	3515
Red shale breaking irregularly	5218.5	4.2	3508
Green shale breaking irregularly. Dip 48° E	5212	6.5	3504
Railroad N. 89° W.			
Massive green sandstone	5502	1.5	3498
Olive-green shale breaking irregularly, with sandstone bands	5199	43.5	3496
Olive-green hackly shale and bands of sandstone bearing *Ambocœlia umbonata*, *Atrypa reticularis*, *Spirifer* (*Delthyris*) *mesacostalis*, *S. mesastrialis* common, *Schizodus chemungensis* common, *Leptodesma* sp., cf. *Palæoneilo crassa*	5118	3.6	3453
Red sandstone and shale	5111	7.3	3449
Sandstone and green shale breaking irregularly	5097	13.3	3442
Bluish-gray sandstone and interbedded shale	5071.5	6.3	3429
Massive greenish-gray sandstone	5061.5	5.3	3422

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Shale breaking irregularly	5049.5	6	3417
Fine-grained conglomerate. Dip 35° E	5038.5	0.5	3411
Sandstone	5037.5	6.2	3410
Green concretionary sandstone. At the top occur *Spirifer (Delthyris) mesacostalis* abundant, *S. mesastrialis* abundant	5028	12.3	3404
Green shale breaking irregularly	5009	8	3392
Upper Chemung conglomerate. One foot above conglomerate occur *Ambocœlia umbonata*, *Atrypa spinosa*, *A. reticularis*, *Spirifer (Delthyris) mesacostalis*	4996.5	0.9	3384
Red sandstone	4992	1.3	3381
Green sandstone and interbedded shale. Sandstone ripple marked. Dip 45° E	4990	11.5	3380
Green shale breaking irregularly	4972	13.5	3368
Concealed. On hillside north of railroad occur at 4509 horizontally (3048 vertically) *Spirifer disjunctus*, at 4614 horizontally (3137 vertically) *Sp. mesastrialis*, 4789 horizontally (3250 vertically) *Sp. mesacostalis*	4949	361.4	3355
Green fissile shale	4338	20	2993
Red sandstone and arenaceous red shale	4304	13	2973
Red shale breaking irregularly	4282	7.9	2960
Fissile green shale and bands of sandstone	4268.5	34.3	2952
Massive red sandstone	4210.5	1.4	2918
Fissile red shale	4208	3.5	2917
Olive-green fissile shale and bands of green sandstone. At top occurs *Spirifer mesastrialis*	4202	17.7	2913
Arenaceous red shale. Dip 40° E	4172	4.7	2896
Fissile green shale and flaggy sandstone	4164	71	2891
Green shale breaking irregularly. Dip 42° E	4048	69	2820
Olive-green shale breaking irregularly. At top in green shale occurs *Ambocœlia umbonata*	3936	32.5	2751
Sandstone at bottom, grading upward into coarse hackly shale and flaggy sandstone. *Spirifer marcyi* var. *superstes*, *Ambocœlia umbonata*, *Tropidoleptus carinatus*, *Coleolus tenuicinctus* were found in a fine-grained sandstone 25 feet east of bottom of unit = 2961 vertically above bottom of section	3886	44	2718
Fissile green shale	3818	11	2674
Massive fine-grained green sandstone	3801	5	2663
Olive green shale breaking irregularly	3793.5	19	2658
Massive greenish-gray sandstone. Dip. 45° E	3764.5	1.9	2639
Coarse conglomerate, lower Chemung conglomerate	3761.5	1.3	2637

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Massive flaggy sandstone and interbedded shale.........	3759.5	15	2636
Fissile green shale and interbedded sandstone	3738	31	2621
Red sandstone	3690	1.9	2590
Fissile olive-green shale and beds of sandstone. Dip 45° E..	3687	92.5	2588
Coarse olive-green shale. In a sandstone at top occur *Spirifer disjunctus* abundant, *Cypricardella* cf. *marylandica* small, *Cypricardella* sp., *Palæoneilo* sp., cf. *Schizodus chemungensis*, *S. oherni* ?, *Bucanopsis mæra*	3545	21.7	2496
Coarse green fissile shale and interbedded sandstone. Dip 48° E..	3513	23.8	2474
Spring and ravine	3478		
Coarse green fissile shale and bands of sandstone. At the top in coarse arenaceous shale are found *Spirifer mesastrialis* abundant	3478	59.2	2450
Dark-green fissile shale and bands of sandstone. Dip 55° E. At top in sandstone are found *Leptostrophia perplana* var. *alternata* abundant, *Palæoneilo perplana*, cf. *Schizodus oherni*, *Bucanopsis mæra*	3398	75.3	2391
Concealed	3298	88	2316
Ravine	3173		
Concealed on railroad. On hillside are beds much the same as in underlying unit. At top of this unit on hillside are found *Ambocœlia umbonata*, *Chonetes scitulus*, *Cyrtina hamiltonensis*, *Spirifer disjunctus* abundant, *S. mesastrialis* common, *S.* (*Delthyris*) *mesacostalis* ?, *Schizodus oherni* common, *Cyclonemina multistriata*, *Cyclonema concinnum*, *Cyclonemina crenulistriata* abundant, *C. crenulistriata* var. *obsolescens*, *Loxonema styliolum* abundant, *L. terebrum*, *Nucula corbuliformis*, *Palæoneilo plana*, *Pterinea chemungensis*, *Schizodus trigonalis*, *Cypricardella crassa* ? abundant, *Bellerphon clarki*, *Loxonema* ? *glabrum*, *Holopea parva*, *Ectomaria marylandica*. These species are limited to a narrow horizon	3173	105.7	2228
Concealed on railroad. On hillside are seen yellow fissile shale, green where not weathered, and some sandstones. At top of this unit are found *Ambocœlia umbonata*, *Leptostrophia perplana* var. *alternata*, *Spirifer disjunctus* abundant, *S. mesastrialis*, *Cyclonemina crenulistriata*, *Loxonema terebrum*. cf. *Cypricardella crassa*, *C. tenuistriata*. This is the lowest occurence of *Spirifer disjunctus* observed in this section	3023	52.8	2122

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green fissile shale and beds of concretionary sandstone, some of the latter two feet thick. Dip 50° E.	2948	46.5	2069
Green fissile shale and beds of flaggy sandstone. Dip 47° E. In a flaggy sandstone at the top occur *Ambocœlia umbonata* abundant, *Chonetes scitulus* common, *Cyrtina hamiltonensis* rare, *Liopteria marylandica*, *Schizodus trigonalis*	2883	86.6	2023
Parkhead Sandstone Member			
Concealed	2754	73.6	1936
Concealed. On the strike from the top of this unit were found *Camarotœchia congregata* var. *parkheadensis* abundant, *Productella lachrymosa*, *Spirifer marcyi* var. *superstes*, *S.* (*Delthyris*) *mesacostalis* abundant, *Tropidoleptus carinatus* abundant, *Cyclonemina multistriata* common, cf. *Holopea rowei*, *Pleurotomaria* (*Gyroma*) *capillaria*, *Goniophoria hamiltonensis*. About 20 feet horizontally and 11.7 feet vertically below the last-named horizon, in shaly sandstone were found *Bucanopsis mæra*, *Bellerphon clarki* abundant, *Orthoceras* cf. *demum*, *Palæoneilo plana*, *Cypricardella gregaria* var.	2554	184	1863
Ravine	2304		
Concealed. On the strike from the beginning of this unit was found in greenish-gray sandstone *Camarotœchia* sp. North of the top of this unit where the ravine branches, in a hard gritty sandstone, were found *Camarotœchia congregata* var. *parkheadensis* abundant, *Tropidoleptus carinatus*, *Coleolus tenuicinctus*, *Bellerphon clarki* abundant, cf. *Liopteria* sp., *Palæoneilo plana*, *Cypricardella gregaria* var., *Goniophoria hamiltonensis*	2304	73.6	1679
Concealed on the Western Maryland Railroad. On the side of the hill above the railroad the base of this interval is seen to be made largely of fissile olive-green shale, above which a great deal of hackly shale juts out on the hillside; 190 feet east (vertical distance 139.8 feet) from the base of this unit, a ledge of hard sandstone is seen on the hill, probably ten feet thick. At the top occur *Camarotœchia congregata* var. *parkheadensis* abundant, *Tropidoleptus carinatus*, *Grammysia elliptica*, *Cypricardella tenuistriata*	2204	478.5	1605

Woodmont Shale Member	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Olive-green shale and sandstone. Dip 54° E.	1554	29.4	1126
Concealed	1514	105.5	1097
Ravine	1364		
Concealed	1364	82.4	992
Olive-green fissile shale. Strike N. 32° E.	1247	12.9	919
Fissile ash-colored and rusty-white shale	1230	5.6	906
Fissile green shale showing slickensides	1222	60	901
Fissile ash-colored and rusty-white shale. Dip 50° E.	1137	3.5	841
Fissile green shale	1132	46.5	837
Concealed	1066	191	791
Railroad N. 89° W.			
Fissile olive-green shale	793	133.5	600
Coarse olive-green arenaceous shale and bands of sandstone. *Buchiola speciosa* fauna. Dip 50° E.	618	106	466
Fissile shale, ash-colored and white. Dip 65° E.	479	4.5	360
Fissile green shale	474	125	356
Coarse green shale breaking irregularly. Dip 45° E.	297	17.5	231
Green fissile shale carrying *Buchiola speciosa* fauna. Dip 45° E.	272	93	213
Hackly green shale and sandstone	140	32.5	120
Concealed. N. 23° E. 60° E.	102	55.2	88
Ravine	38		
Genesee Member			
Concealed. Some black shale seen on hillside. Genesee fauna	38	32.5	32
Romney-Jennings contact	0		0

ROMNEY FORMATION

Massive sandstone.

The upper and lower conglomerates of the Chemung are well exposed, the Tropidoleptus carinatus fauna recurring a short distance above the latter. A conspicuous feature is the red bed of Catskill type seen in the small hill near the mouth of Town Creek above which sediments of Jennings type carrying marine fossils recur.

XV. Section Two Miles North of the mouth of Town Creek[1]

An almost uninterrupted exposure of the lower 2000 feet of the Jennings occurs on Town Creek two miles in an air line north of its mouth where it makes a long swing to the east. The section is seen on the south side of the creek beginning at the Romney-Jennings contact and extending eastward 2767 feet.

JENNINGS FORMATION *Chemung Sandstone Member* Stream N 65° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green hackly shale and interbedded sandstone. Dip 53° E.	2767	292.8	2241
Parkhead Sandstone Member			
Shale breaking irregularly and concretionary sandstone. At top occur *Tropidoleptus carinatus* abundant, *Spirifer (Delthyris) mesacostalis*, *S. mucronatus* var. *posterus* ?, *Coleolus tenuicinctus*, *Cyclonemina multistriata*, *Bellerphon clarki*, *Loxonema ? glabrum*	2407	31.7	1949
Fissile green shale and beds of sandstone. At top occur *Camarotœchia congregata* var. *parkheadensis*, *Spirifer (Delthyris) mesacostalis*, *Tropidoleptus carinatus* common. Dip 65° E.	2372	75.1	1917
Concealed. Near the top of this unit were found *Cyrtina hamiltonensis*, *Spirifer mucronatus* var. *posterus* ?, *Tropidoleptus carinatus* abundant, *Coleolus tenuicinctus*, *Loxonema ? glabrum* common	2289	21.8	1842
Green sandstone with partings of shale breaking irregularly	2266	43.7	1820
Ravine	2220		
Green shale breaking irregularly and sandstone in about equal amounts	2220	40.8	1776
Green shale breaking irregularly	2177	22.3	1736
Arenaceous shale breaking irregularly, and sandstone, containing at top *Camarotœchia congregata* var. with deeper sinus suggesting *contracta* abundant, *Spirifer marcyi* var. *superstes*, *S. (Delthyris) mesacostalis*, *S. mesastrialis*, *Tropidoleptus carinatus* abundant, *Spirorbis* sp., *Cyclonemina multistriata*, *Bellerphon clarki*, *Loxonema ? glabrum*. At 2146 horizontally (1716 vertically) occur *Camarotœchia congregata* var. *parkheadensis*, *Cypricardella bellistriata*, *C. tenuistriata*, *Nucula corbuliformis* abundant, *Holopea ? parva*	2154	9.9	1723

[1] Measured by tape.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Dark bluish sandstone	2143.5	7.6	1713
Green fissile shale, bands of dark-blue sandstone. In a band of bluish sandstone 10 feet from bottom of unit (1686.8 vertically) occur *Camarotœchia congregata* var. *parkheadensis* abundant. N. 24° E. 73° E.	2135.5	28.5	1706
Green fissile shale	2105.5	35	1677
Dark bluish sandstone and interbedded shale containing near the top *Camarotœchia congregata* var. *parkheadensis* common, *Tropidoleptus carinatus*, *Cypricardella bellistriata*, *C. gregaria* var., *Liopteria bigsbyi* ?	2066.5	10	1632
Green fissile shale and an occasional band of bluish sandstone. Dip 65° E.	2055.5	102	1632
Green fissile shale and an occasional band of bluish sandstone. Dip 72° E.	1941.5	180	1530
Green fissile shale carrying at top in a thin band of bluish sandstone *Spirifer (Delthyris) mesacostalis*, *Tropidoleptus carinatus*. N. 25° E. 59° E.	1751.5	38	1350
Dark bluish sandstone with shale partings containing at top *Camarotœchia congregata* var. *parkheadensis* abundant, *C. eximia*, *Liopteria bigsbyi* ?, *Paleoneilo* cf. *maxima*.	1707.5	6.5	1312
Fissile green shale and sandstone	1699.5	23.5	1306
Fissile green shale and thin-bedded sandstone containing at top in a band of sandstone *Camarotœchia congregata* var. *parkheadensis*, *Tropidoleptus carinatus*, *Cypricardella gregaria* var., *Palæoneilo* cf. *maxima*. N. 27° E. 57° E.	1671.5	31	1282
Dark bluish sandstone	1633.5	1.6	1251
Woodmont Shale Member			
Fissile green shale with interbedded sandstone	1631.5	32	1250
Hard green sandstone and fissile green shale	1592.5	18.5	1218
Green fissile shale and bands of hard green and blue sandstone. N. 32° E. 57° E.	1569.5	72.5	1199
Fissile green shale	1482.5	43	1127
Green shale breaking irregularly with thin bands of green and hard blue sandstone. N. 29° E. 58° E.	1431.5	35	1084
Fissile green shale with bands of hard green and blue sandstone. N. 32° E. 65° E.	1390.5	90.5	1049
Stream N. 70° W.			
Concealed	1290.5	212	958
Shale breaking irregularly and concretionary sandstone. N. 25° E. 59° E.	1040.5	23.7	746

Stream N. 75° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green shale breaking irregularly and concretionary sandstone	1012.5	51	722
Green shale breaking irregularly. N. 32° E. 50° E.	943.5	28.7	671
Green shale breaking irregularly. Dip 58° E.	903.5	58	643
Green shale breaking irregularly. Dip 62° E.	832.5	42.5	585
Concealed	782.5	24	542
Shale breaking irregularly. N. 30° E. 40° E.	743.5	39.1	518
Concealed	680.5	209	479
Fissile green shale and bands of flaggy sandstone containing *Buchiola speciosa* fauna at top	343.5	61.9	270
Coarse green shale and thin bands of flaggy sandstone.	265.5	31.5	208
Fissile green shale. N. 27° E. 55° E.	226	139.8	177
Genesee Member			
Black shale containing *Buchiola speciosa* fauna, grading into green above. N. 25° E. 49° E.	50	37	37
Romney-Jennings contact	0		0
ROMNEY FORMATION			
Massive sandstone.			

The absence of the Ithaca fauna is especially to be noted here, the Naples fauna probably ranging through the lower 1200 feet of strata.

XVI. Section on National Road West of Green Ridge[1]

The section begins at the intersection of the National Road with a road leading to the north, on the east side of Fifteenmile Creek, and extends to the Jennings-Catskill contact on the east side of Green Ridge. It begins near the base of the Parkhead member.

JENNINGS FORMATION *Chemung Sandstone Member* Road N. 63° E.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Jennings-Catskill contact. Many fossils	0	0	4717
Bridge over Piney Run. Map altitude 935, many fossils on strike 200 feet east of bridge, north of creek	200	80	4637

[1] Measured by pacing.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Road N. 40° E. Map altitude 935			
Green fissile shale. N. 30° E. 40° E	1150	125	4512
Bright-red fissile shale. Dip 50° E	1225	13	4499
Fissile green shale	1345	19	4480
Road N. 50° W. Map altitude 990			
Bright-red fissile shale. Upper limit red lentil, some green shale in unit. N. 25° E. 40° E	1605	149	4331
Red sandstone and shale	1635	17	4314
Red fissile shale	1785	85	4229
Road N. 35° E.			
Red fissile shale, partially concealed at top. Exposure in fields	1935	11	4218
Road N. 20° E.			
Red shale mostly hackly ascending stratigraphically	2035	5	4223
Flaggy red sandstone and interbedded red and green shale. Ascending stratigraphically	2135	5	4228
Road N. 50° E. Map altitude 1040			
Red shale exposed in field	2285	20	4208
Fissile red shale. House on right. Base red lentil	2635	48	4160
Road N. 55° E. Map altitude 1060			
Concealed in road. Green fissile shale in field	2885	70	4097
Fissile green shale and beds of flaggy sandstone	3035	42	4055
Green and dull-red shale. Two colors equal. Dip 45° E.	3485	145	3910
Mostly concealed, green shale seen	3735	79	4831
Hard gray sandstone. Several layers coarse conglomerate. N. 30° E. 45° E	3820	27	4804
Road N. 75° E. Map altitude 1140			
Green shale. Lower part concealed	4470	311	3493
House	4470		
Road N. 50° E.			
Concealed. Conglomerate at bottom of unit, very fossiliferous. *Ambocœlia umbonata, Spirifer (Delthyris) mesacostalis.* Upper Chemung conglomerate	4820	93	3400

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Top of ridge. Map altitude 1206			
Green fissile shale and interbedded flaggy sandstone, some sandstone dull red	5570	269	3131
Road N. 35° E.			
Green fissile shale. Dip 45° E.	5920	64	3067
Road N. 65° E. Map altitude 1130			
Green fissile shale, some red	6170	147	2928
Road N. 20° E. Map altitude 1100			
Fissile green shale	6570	1	2921
Road N. 75° W. Map altitude 1070. Acute turn to north in going west			
Green fissile shale. Beds flaggy sandstone, some dull-red shale. *Spirifer marcyi* var. *superstes*, zone probably at bottom of this unit. Dip 55° E. Horizon of lower Chemung conglomeate	6920	231	2690
Green fissile shale. Some dull-red. Much "kindling-wood" fracture. N. 32° E. 47° E.	7420	350	2340
Fissile green shale	7745	226	2114
Road N. 35° E. Map altitude 980. House at turn of road			
Olive-green shale, some hackly. Sandstone at bottom...	8095	27	2087
Fissile green shale	8895	65	2022
Road N. 80° E. Map altitude 800			
Mostly fissile green shale. Some red "kindling-wood" shale at top. *Spirifer disjunctus* occurs at 9200 horizontally (1850 vertically)	9295	229	1793
Parkhead Sandstone Member			
Road N. 95° W. Map altitude 780			
Mostly fissile green shale. Some breaking irregularly, some sandstone, some red shale at top. N. 35° E. 50° E. *Camarotœchia congregata* var. *parkheadensis* occurs at 9745 (1500 vertically)	9945	422	1371
Green fissile and hackly shale and interbedded sandstone. *Liorhynchus* sp. near base	1029.5	227	1144
End of section at fork of road. Map altitude 745	1029.5		1144

The recurrence of the Tropidoleptus carinatus fauna at the horizon of the lower Chemung conglomerate, as shown by the presence of *Spirifer marcyi* var. *superstes* 2690 feet above the base of the Jennings, is of especial interest. The red bed in the upper part of the Chemung is seen on the east side of the ridge, where it is overlain by strata containing many marine fossils.

Two fine sections are exposed on the west slope of Polish Mountain, one on the National Road and one on the Williams Road east of Rush. Both extend from the base of the Jennings to the upper Chemung conglomerate, which is found near the top of the mountain. While the lower Chemung conglomerate could not be identified with certainty, it is well displayed in many localities east of Polish Mountain where it contains the recurrent Tropidoleptus carinatus fauna.

XVII. Section on Williams Road, Polish Mountain[1]

This section begins at the Romney-Jennings contact, approximately 200 feet west of the sharp turn in the road west of Town Creek, and extends to the cross roads on the top of the mountain.

JENNINGS FORMATION *Chemung Sandstone Member*	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Cross roads at top of mountain. Altitude by barometer 1450. Map altitude 1480	10460		3456.5
Road S. 65° E.			
Concealed	10460	23	3456.5
Green shale breaking irregularly. Massive coarse conglomerate at top	10400	27	3433.5
Road S. 35° E.			
Arenaceous shale breaking irregularly. Dip 20° E.	10330	31.5	3406.5
Concealed	10230	31.5	3375

[1] Measured by pacing.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Road N. 45° E. Altitude by barometer 1440			
Concealed. Ravine	10130	39.5	3343.5
Concealed. Probably chiefly heavy sandstone which is in fragments on hillside	9990	17	3304
Road S. 70° E. Altitude by barometer 1410. Map altitude 1450			
Shale breaking irregularly and bands of flaggy green sandstone. Dip 20° E	9930	172	3287
Road N. 85° E.			
Hackly and smooth shale. Dip 30° E	9250	161.5	3111.5
Road S. 70° E.			
Green shale breaking irregularly. Dip 17° E	9230	44	3053.5
Concealed. On hillside occur loose *Spirifer* (*Delthyris*) *mesascostalis* cardinal angles extended	9110	23	3009.5
Road N. 45° E. Altitude by barometer 1330			
Green fissile shale	9050	41	2986.5
Road N. 85° E. Map altitude 1400			
Green fissile shale	8870	76	2945.5
Road S. 80° E. Altitude by barometer 1310			
Hackly and smooth green shale	8670	102	2869.5
Splintery and fissile shale. Dip 20° E	8430	42	2767.5
Green fissile shale. A bed of sandstone and shale about 10 feet thick at base bears *Camarotœchia* sp., *Spirifer* (*Delthyris*) *mesacostalis*, *S. disjunctus*	8330	17	2727.5
Splintery shale. In a thin bed of sandstone at top occur *Atrypa spinosa*, *Spirifer disjunctus*, *S.* (*Delthyris*) *mesacostalis* abundant	8290	21	2708.5
Road S. 60° E.			
Green fissile shale	8240	97	2681.5
Road S. 5° E. Altitude by barometer 1250. Map altitude 1280			
Green shale breaking irregularly. Road to south	8000	29.5	2590.5
Concealed	7820	11.5	2651

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Road S. 50° E.			
Concealed	7750	66	2549.5
Green shale and some sandstone. In a sandstone at top occur *Atrypa spinosa*, *Productella* sp.	7570	40	2483.5
Road S. 25° E. Map altitude 1260			
Largely concealed. Fissile green shale	7460	61	2443.5
Concealed. At top in a brown sandstone associated with a conglomerate occur *Spirifer disjunctus*, *S.* (*Delthyris*) *mesacostalis* abundant, *Schizodus oherni*, *Modiomorpha subangulata* var. Thickness of sandstone and conglomerate is not known	7230	21	2382.5
Road S. 40° E. Map altitude 1200			
Largely concealed. A green sandstone about middle probably 8 to 10 feet thick	7151	81	2361.5
Road N. 55° E. Map altitude 1150			
Concealed, second sharp turn at ravine	6880	35	2279.5
Road from northwest, green hackly shale at bottom, green shale at top	6770	45.5	2244.5
Concealed	6630	23	2199
Road N. 25° E. Map altitude 1150			
Green fissile shale, beds of flaggy sandstone with zones of red shale near top. Dip 20° E.	6560	72	2176
Mostly concealed, green fissile shale in places	6140	22	2104
Shale and red sandstone, sandstone very red	6010	10	2082
Road N. 55° E.			
Green shale breaking irregularly and sandstone. Dip 20° E.	5950	30	2072
Road N. 90° E. Altitude by barometer 1070. Map altitude 1060			
Fissile green shale, bands of brown sandstone. At top occur *Atrypa reticularis*, *Leptostrophia perplana* var. *alternata* abundant, *Productella lachrymosa* var. *marylandica* but larger than usual, abundant, *P. lachrymosa*, *Pterinea chemungensis*, *Cypricardella crassa* ?, *Platyceras marylandicum*, *Manticoceras patersoni*, *Orthoceras consortale* common	5860	75	2042

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Fissile green shale and some sandstone. At top in some coarse shaly sandstone occur *Productella lachrymosa* var. *marylandica*, but larger than usual, *Schizophoria striatula* smaller than usual, *Spirifer disjunctus*, *Gosselletia* sp......	5680	58	1967
Sandstone and shale	5520	29	1909
Fissile green shale. Dip 20° E. In band of sandstone at bottom occurs *Ambocœlia umbonata*	5470	33	1880
Parkhead Sandstone Member			
Fissile green shale	5390	92	1847
Road S. 85° E. Map altitude 1000			
Green shale breaking irregularly and bands of sandstone.	5180	36	1755
Green fissile shale	5100	59	1719
Road S. 75° E. Map altitude 960			
Fissile green shale. At top a bed of sandstone, perhaps 10 feet thick, in which are found *Atrypa reticularis*, *Camarotœchia congregata* var. with deeper suggesting *contracta*, *Craniella hamiltoniæ*, *Cyrtina hamiltonensis*, *Productella lachrymosa* abundant, *Schizophoria impressa*, *Spirifer* (*Delthyris*) *mesacostalis*, *S. marcyi* var. *superstes* abundant, *Tropidoleptus carinatus* abundant, *Coleolus tenuicinctus* abundant, *Bucanopsis mæra*, *Bellerophon clarki*, *Cyclonema concinnum*, *Cyclonemina multistriata* abundant, *Straparollus marylandicus*, *Loxonema hamiltoniæ*, *L.* ? *glabrum* abundant, *Ectomaria marylandica*, *Platyceras marylandicum* common, *Orthonychia unguiculata* common, *Loxonema styliolum* ?, *Cypricardella tenuistriata*, *Goniophora truncata* common, *Liopteria bigsbyi*, *Cypricardella* sp. *Phacops rana*	4970	28	1660
Green shale breaking irregularly. At top *Spirifer* (*Delthyris*) *mesacostalis*, *Tropidoleptus carinatus*	4910	21	1632
Fissile green shale	4865	56.5	1611
Green shale breaking irregularly	4745	4.5	1554.5
Fissile green shale	4735	29	1550
Road S. 27° W. Map altitude 920. Altitude by barometer 940			
Shale and sandstone	4675	41.5	1521

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Road N. 48° E. Map altitude 940			
Concealed to where road turns sharply to southwest at ravine	4175	20	1562.5
Shale breaking irregularly	4095	18	1542.5
Concealed. At top in a band of hard dark sandstone *Camarotœchia congregata* var. *parkheadensis*, *Spirifer* (*Delthyris*) *mesacostalis*	4025	51	1524.5
Fissile green and hackly shale	3825	51	1473.5
Green fissile shale. Beds of brown sandstone. At top carrying *Chonetes scitulus*, *Rhipidomella vanuxemi*, *Tropidoleptus carinatus*. Dip 25° E.	3625	51	1422.5
Road N. 85° E. Map altitude 900			
Green fissile shale. Beds of hard blue sandstone at top containing *Camarotœchia congregata* var. *parkheadensis* common, *C. eximia*, *Chonetes scitulus*, *Rhipidomella vanuxemi*, *Tropidoleptus carinatus* common	3425	19	1371.5
Green fissile shale bands of bluish sandstone carrying at top *Camarotœchia congregata* var. *parkheadensis* common, *C. eximia*, *Tropidoleptus carinatus*, *Loxonema styliolum* ?, *L.* ? *glabrum*, *Cypricardella gregaria* var. *Goniophora hamiltonensis*, *Nucula corbuliformis*, *Schizodus trigonalis*	3385	63	1352.5
Road N. 75° E.			
Green shale and bands of sandstone. At top in dark sandstone occur *Camarotœchia congregata* var. *parkheadensis* abundant, *C. eximia*, *Chonetes scitulus*, *Rhipidomella vanuxemi*, *Spirifer* (*Delthyris*) *mesacostalis* ?, *Tropidoleptus carinatus* abundant, *Sandbergeroceras chemungensis*, *Aviculopecten* cf. *cancellatus*, *Grammysia subarcuata*, *Liopteria bigsbyi* ?, *Palæoneilo* sp. Dip 25° E.	3250	84	1289.5
Concealed	3060	43	1205.5
Green fissile shale. At top occur *Camarotœchia congregata* var. *parkheadensis*, *Leptodesma naviforme*. Dip 24° E.	2960	13	1162.5
Woodmont Shale Member			
Concealed	2930	229.5	1149.5
Green fissile shale	2400	115	920
Road N. 60° E. Map altitude 820			
Green fissile shale. Dip 26° E.	2140	72	805
Green shale, mostly hackly	1960	24	733
Green fissile shale. Dip 26° E.	1900	84	709

Road N. 40° E. Map altitude 890	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Green fissile shale. At top in a shale occurs the *Buchiola speciosa* fauna (*Pterochænia*, etc.)	1690	39	625
Road N. 60° E.			
Green fissile shale. Dip 28° E. At top occurs the *Buchiola speciosa* fauna	1530	50	586
Concealed. Dip 28° E	1400	460.5	536
Road S. 79° E. Map altitude 740			
Concealed	200	76.5	76.5
Romney-Jennings contact is concealed. Position approximate	0		0

The great profusion of fossils in the Parkhead member and the occurrence of bright-red strata just above the base of the Chemung member are interesting features of the foregoing section.

XVIII. Section on National Road, Polish Mountain [1]

The Jennings is well exposed on the National Road on the western slope of Polish Mountain. The section begins at the Romney-Jennings contact, 450 feet west of the center of the bridge over Town Creek and extends to the cross roads on the top of the mountain. It is continued above this point on the road leading to the southwest on Polish Mountain.

JENNINGS FORMATION *Chemung Sandstone Member*	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Concealed. A conglomeratic sandstone near top of mountain		75	3375
Concealed. A massive conglomeratic sandstone crosses the road which leads southwest from National Road. Its outcrop is 1740 from National Road and its map altitude 1560 feet. The interval from it to crossroad largely concealed. The remainder of the section is on the National Road	10565	200	3300

[1] Measured in 1907 by pacing. Revised from instrumental surveys of Highway Division, Md. Geol. Survey. Corrected altitudes are from latter survey.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Crossroad at top of mountain, 1380 altitude. Map altitude 1372	8825		3119
Road N. 55° E.			
Shale breaking irregularly, beds of heavy sandstone, N. 20° E. 18° E., and N. 40° E. 17° E. At top of mountain, N. 32° E. 14° E	8825	83	3119
Fissile and hackly green shale and some sandstone. At top *Spirifer mesastrialis* in a bed of sandstone, probably 6 feet thick. Dip 18° E	8440	87	3036
Fissile green shale and beds of sandstone. At top a band of sandstone occurs containing *Camarotœchia* sp., *Atrypa spinosa, Spirifer disjunctus, S.* (*Delthyris*) *mesacostalis*	8220	20	2449
Fissile green shale. At top occur *Camarotœchia contracta, Spirifer* (*Delthyris*) *mesacostalis* abundant, *S. mesastrialis, Loxonema styliolum, Pterinea chemungensis*	8175	28	2929
Splintery shale breaking irregularly. N. 30° E. 15° E	8098	61	2901
Road N. 55° E. Map altitude 1298			
Green arenaceous shale breaking irregularly. N. 32° E. 22° E	7911	68	2840
Road N. 85° E. Altitude 1278. Map altitude 1275			
Hackly and splintery green shale. N. 29° E. 17° E	7669	58	2772
Green shale breaking irregularly. At top occur *Pterinea chemungensis* ?, *Liopteria* sp. large near *L. bigsbyi*	7504	18	2714
Road N.-S. Altitude 1256. Map altitude 1240			
Going down stratigraphically. Green shale breaking irregularly, N. 22° E. 15° E	7449	10	2696
Going down stratigraphically. Hackly green shale. At bottom occurs *Schuchertella chemungensis* abundant, *Douvillina cayuta* ?, *Zaphrentis marylandica* abundant, *Z. chemungensis* abundant, *Spirifer* (*Delthyris*) *mesacostalis* common, *S. mesastrialis* abundant, *Atrypa spinosa, Pterinea chemungensis, Camarotœchia contracta.* Dip 16° E	7314	8	2706
Concealed. Going down stratigraphically. N. 27° E 14° E	7231	6	2714

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Road N. 65° W. Altitude 1239. Map altitude 1240			
Mostly concealed. Some fissile shale, bands of sandstone	7137	69	2720
Second sharp turn around head of ravine. Mostly concealed. N. 35° E. 14° E	6929	54	2797
Shale breaking irregularly. Dip 20° E	6763	94	2597
Road N. 45° W. Map altitude 1220. Altitude 1183			
Splintery and hackly shale. About 10 feet vertical from bottom a brown sandstone probably 10 feet thick. At the top of this unit in argillaceous shale occur *Ambocœlia umbonata, Grammysia subarcuata.* N. 6° E. 13° E. and N. 36° E. 20° E	6545	82	2503
Road N. 60° E. Map altitude 1150. Altitude 1162			
Largely splintery shale	6337	31	2421
Road N. 60° E. Altitude 1155. Map altitude 1150			
Concealed	6212	52	2390
Road N. 50° W. Altitude 1148. Map altitude 1140			
Fissile shale and flaggy sandstone. Dip 23° E	6087	106	2338
Fissile shale and flaggy sandstone	5858	47	2232
Shale breaking irregularly and sandstone. At top *Spirifer disjunctus, Productella lachrymosa.* Dip 20° E	5744	26	2185
Fissile green shale, massive sandstone near base. At top *Spirifer (Delthyris) mesacostalis.* N. 28° E. 18° E	5681	85	2159
Road N. 85° E. Altitude 1099. Map altitude 1100			
Fissile green shale bands and sandstone	5536	20	2104
Concealed	5484	68	2084
Road N. 75° W. Altitude 1078. Map altitude 1090			
Fissile green shale with bands of sandstone. At top in hackly green shale occur *Spirifer disjunctus, S. (Delthyris) mesacostalis, Productella* sp. Dip 25° E	5328	137	2016
Second-class road to southeast 30 feet from next turn.			
Road N. 11° E. Altitude 1056. Map altitude 1070			
Going down stratigraphically. Fissile green shale, bands of sandstone. N. 25° E. 31° E	5047	32	1879

Road N. 23° W. Altitude 1031. Map altitude 1080	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Fissile green shale and bands of sandstone. Dip 30° E. Going down stratigraphically	4704	46	1911
Fissile green shale. Going down stratigraphically. At bottom *Ambocœlia umbonata.* Dip 25° E.	4548	40	1957
Road N. 50° E. Altitude 1002. Map altitude 1070			
Concealed. Ravine. Sharp turn to left in ascending mountain. N. 21° E. 25° E.	4361	28	1997
Road N. 50° W. Altitude 995. Map altitude 1060			
Green fissile shale. Dip 23° E.	4236	12	1969
Parkhead Sandstone Member			
Green fissile shale		89	1957
Massive sandstone. N. 27° E. 30° E.	4007	5	1868
Largely concealed. Green shale and sandstone showing in places. Dip 30° E.	3997	238	1625
Shale breaking into irregular pieces and concretionary sandstone. A massive sandstone at 3520 horizontal. N. 27° E. 35° E.	3571	65	1625
Fissile green shale. At top occur *Camarotœchia congregata* var. *parkheadensis*, *Spirifer* (*Delthyris*) *mesascostalis*, *S. marcyi* var. *superstes*, *Cyclonemina multistriata*, *Phacops rana.* Dip average 35°	3467	134	1560
Road N. 77° W. Altitude 909. Map altitude 920			
Fissile green shale. At bottom in a sandstone occurs *Camarotœchia congregata* var. *parkheadensis*, *Spirifer marcyi* var. *superstes*, *Tropidoleptus carinatus*, *Leptodesma naviforme*, *Bellerophon clarki*, *Lioptera bigsbyi* ?, *Palæoneilo brevis* ?	3259	230	1426
Woodmont Shale Member			
Fissile green shale	2937	71	1196
Road N. 45° E. Altitude 869. Map altitude 880			
Fissile green shale. Average dip 31°	2812	53	1125
Road N. 10° E. Altitude 853. Map altitude 870			
Largely fissile green shale. Ascending stratigraphically. N. 29° E. 30° E.	2594	20	1072

Road N. 55° W. Altitude 821. Map altitude 860	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Stone bridge	2220		1092
Concealed. Dip 30° E.	220	735	1092
Black and green fissile shale. Buchiola speciosa fauna. Dip 30° E. At 760 occurs *Cyclonema* sp. resembles *concinnum*	760	161	357
Road N. 79° W. Altitude 770			
Town Creek	450		196
Concealed. Dip 30° E. Genesee shale in interval	450	196	196
Romney-Jennings contact. 450 feet west of center of bridge over Town Creek	0		0

XIX. Section near Round, West Virginia

The Jennings occupies a syncline west of Warrior Mountain, which deepens south of the Potomac River. The lower Chemung conglomerate is exposed on top of a hill west of the home of Mr. J. Will Smith, the locality being on the county line between Mineral and Hampshire counties, 2¾ miles in an airline southwest of Round, West Virginia. The section is of interest because of the abundant development of the recurrent Tropidoleptus carinatus fauna in the lower Chemung conglomerate. The following species were collected in these beds: *Ambocœlia umbonata* abundant, *Camarotœchia congregata* var. *parkheadensis, Rhipidomella vanuxemi, Spirifer marcyi* var. *superstes, Tropidoleptus carinatus* abundant. The underlying rocks are exposed in a ravine that descends in a northeasterly direction from the home of Mr. Smith, along an old road leading to Green Spring. The lower part of the Chemung consists largely of strata having a deep-red color, below which the Parkhead member is seen in the ravine.

XX. Section on Williams Road East of Cumberland[1]

The lower Jennings is admirably exposed on the Williams Road west of Mt. Hermon Church, 3½ miles east of Cumberland. The section begins at the Romney-Jennings contact and extends 1908 feet to the west. The measurements were made on the old road and do not apply to the new road constructed in 1911, which follows another course.

[1] Measured by tape.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
JENNINGS FORMATION			
Parkhead Sandstone Member			
Road N. 80° W.			
Shale chiefly dark and bands of flaggy sandstone. At the top occur *Chonetes scitulus* common, *Productella navicelliformis* common, *Spirifer marcyi* var. *superstes* abundant, *Tropidoleptus carinatus* abundant, *Liopteria bigsbyi*, *Orthoceras* sp.	1908	72.9	1466
Fissile shale, green below, grading into black above. At top occur *Camarotœchia congregata* large, *Lingula oherni* abundant, *Liorhynchus mesacostalis* abundant, *Orbiculoidea* cf. *media*, *Rhipidomella vanuxemi*, *Spirifer* (*Delthyris*) *mesacostalis* ?, cf. *Ptychodesma* sp., *Leptodesma naviforme*	1812	76	1393
Road N. 22° W.			
Woodmont Shale Member			
BEDS CONTAINING NAPLES FAUNA			
Green fissile and splintery shale	1712	21.2	1317
Sandstone with shale partings. Dip 50° W.	1662	7.6	1296
Shale and flaggy sandstone	1644	13.6	1288
Concealed	1599	26.3	1274
Road N. 55° E.			
Concealed	1549	44	1248
Fissile olive-green shale and flaggy sandstone	1479	31.4	1204
Fissile olive-green shale weathering to ashen-white	1429	47.2	1173
Road N. 55° W.			
Fissile olive-green shale weathering to ashen-white	1354	43.2	1125
Fissile olive-green shale	1304	39.7	1082
Green shale breaking irregularly. Dip 70° W.	1258	43.2	1043
Road N. 95° W.			
Concealed	1208	40.4	999
Road N. 70° W.			
Fissile green shale. N. 12° E. 65° W.	1161	131.3	959
Road N. 95° W.			
Green fissile shale	1014	127.7	828
Green fissile shale bearing at top *Pterochemia* sp.	864	34	700

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Road N. 30° W.			
Green fissile shale. Dip 70° W.	824	124.5	666
Green fissile shale bearing at top the *Buchiola speciosa* fauna	651	21	541
Green fissile shale bearing at top *Buchiola speciosa* fauna. Dip 67° W.	621	52	520
Road N. 45° W.			
Green fissile shale bearing *Goniatites* at top. Dip 67° W.	547	62.6	468
Shale and shaly sandstone bearing *Buchiola speciosa* fauna at top	471	33.3	406
Green fissile shale. N. 20° E. 50° W. bearing *Buchiola speciosa* fauna throughout	423	34.4	373
Road N. 80° E.			
Concealed	373	30	338
Fissile green shale. N. 15° E. 61° W.	335	32.2	308
Road N. 75° W.			
Green fissile shale bearing at top *Buchiola speciosa* fauna. N. 15° E. 70° W.	294	186	276
Genesee Black Shale Member			
Black shale bearing Genesee fauna. (Thickness approximate)	100	90	90
Romney-Jennings contact	0		0
ROMNEY FORMATION			
Yellowish-green shale weathering into irregular fragments		56	
Massive sandstone.			

The Ithaca fauna was not observed, the Naples fauna appearing to range throughout the Woodmont member. The *Liorhynchus mesacostale zone* is well developed at the base of the Parkhead member. An interesting feature is the profusion of *Spirifer marcyi* var. *superstes* in the Park-

head member, a form found abundantly in the western sections, but occurring less frequently in the east.

A number of excellent exposures of the Jennings are to be seen in the Cumberland syncline, south of the Potomac River in West Virginia. The best of these are along Rocky Run on the Baltimore and Ohio Railroad cut-off, and on Turners Run Road east of Knobly, seven miles southwest of Cumberland. At the former locality at the base of the Parkhead occur *Chonetes scitulus, Cyrtina hamiltonensis, Rhipidomella vanuxemi, Schizophoria striatula, Spirifer marcyi* var. *superstes* abundant, *Tropidoleptus carinatus, Cyclonemina multistriata, Pleurotomaria* (*Gyroma*) *capillaria* ? At the same horizon at the latter locality occur *Chonetes scitulus, Spirifer marcyi* var. *superstes, Spirifer* (*Delthyris*) *mesacostalis.*

Sections West of Wills Mountain

The sections of the Jennings exposed west of Wills Mountain differ both lithologically and faunally from those east of Wills Mountain. Among the conspicuous differences observed are the lesser thickness of the formation, the larger development of shale in the lower beds, rendering the Parkhead member scarcely distinct, the occurrence of conglomerates in the middle of the Chemung, and the absence of the red band so prominent in the upper part of the Chemung in many of the eastern sections.

The sections are exposed in two areas, the Keyser area and the Oakland anticline. The sections in the Keyser area will be considered in the order of their location from the northeast to the southwest.

XXI. Section at Ellerslie, Pennsylvania[1]

The lower Jennings is exposed in a ravine north of and parallel to the tramway from Ellerslie to the fire-clay mine on Little Allegany Mountain. The section begins at the Romney-Jennings contact and extends westward 1911 feet.

[1] Measured by pacing.

JENNINGS FORMATION

Chemung Sandstone Member

Direction of run N. 40° W.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Concealed. At bottom of this concealed unit in thin-bedded gray sandstone were found *Ambocœlia umbonata*, *Atrypa spinosa*, cf. *Craniella* sp., *Dalmanella tioga* common, *Douvillina cayuta*, *Schuchertella chemungensis*, *Spirifer mesastrialis*, *Leptodesma longispinum* small, *L.* sp., *Pterinea chemungensis* abundant	1911	16	1524

Direction of run N. 20° W.

Concealed	1893	11	1508
Interbedded arenaceous green shale and gray sandstone. At 1847 horizontally (1474 vertically) occur *Ambocœlia umbonata* abundant, *Atrypa spinosa* abundant, *Craniella hamiltoniæ*, *Dalmanella carinata*, *D. tioga* abundant *Chonetes* sp., *Douvillina cayuta* common, *Productella lachrymosa* var *marylandica* ?, *P. lachrymosa* var. approaching *speciosa* common, *Schizophoria striatula* common, *Spirifer disjunctus* abundant, *S.* (*Delthyris*) *mesacostalis*, *Schuchertella chemungensis* abundant, *Pterinea chemungensis* abundant	1878	37	1497

Direction of run due W.

Thin-bedded green arenaceous shale	1828	14	1460

Direction of run N. 50° W.

Heavy-bedded grayish-green sandstone	1811	5	1446
Largely concealed, with some thin bands of grayish-green sandstone at bottom	1806	57	1441
Thin-bedded grayish-green sandstone and interbedded arenaceous green shale. At 1680 horizontally (1316 vertically) occur *Cladochonus humilis*, *Atrypa hystrix*, *A. spinosa*, *Dalmanella tioga* abundant, *Douvillina cayuta*, *Schuchertella chemungensis* abundant, *Productella lachrymosa* var. approaching *speciosa*, *Spirifer disjunctus* abundant, *Pterinea chemungensis* abundant, *Pleurotomaria* sp.	1749	125	1384

Direction of run N. 45° W.

Concealed	1620	83	1259

Parkhead Sandstone Member	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Concealed	1533	21	1176
Thin-bedded gray sandstone	1512	4	1155
Gray sandstone in beds 6 to 8 inches thick	1508	3	1151
Concealed	1505	37	1148
A second-class road crosses here	1467		
Concealed	1467	63	1111
Direction of run N. 75° W.			
Thin-bedded gray sandstone	1393	18	1048
Concealed	1375	31	1030
Direction of run S. 35° W.			
Thin-bedded fissile green arenaceous shale and interbedded green sandstone 2 to 4 inches thick	1343	12	999
Concealed	1254	12	987
Direction of run N. 55° W.			
Fissile green arenaceous shale with interbedded thin bands of gray flaggy sandstone; shale weathering somewhat hackly	1163	45	975
Direction of run N. 45° W.			
Green arenaceous shale with some interbedded green flaggy sandstone near the bottom	1118	29	930
Thin-bedded flaggy bluish-green sandstone and some interbedded green arenaceous shale	1088	19	901
Direction of run N. 55° W.			
Thin-bedded arenaceous green shale and interbedded bluish-green flaggy sandstone. Sandstone more prominent near the top where beds become 6 inches to 1 foot thick. N. 27° E. 90° E.	1068	69	882
Woodmont Shale Member			
BEDS CONTAINING NAPLES FAUNA			
Thin-bedded fissile green shale and interbedded thin sandstone. Partially concealed	998	48	813
Direction of run N. 85° W.			
Thin-bedded olive-green shale and interbedded bands of green sandstone. Partially concealed	948	46	765

Direction of run N. 75° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Thin-bedded green shale and interbedded grayish-green sandstone	898	57	719
Thin-bedded green shale. N. 27° E. 80° W.	838	38	662
Grayish-green shale with interbedded thin gray sandstone in courses, 1 foot thick near bottom of unit	798	21	624
Concealed	776	27	603
Direction of run N. 65° W.			
Dark bluish-black and green fissile shale and occasional bands of sandstone 2 to 3 inches thick. Dip 90°	748	48	576
Direction of run due W.			
Olive-green fissile shale	648	49	528
Direction of run S. 45° W.			
Fissile green shale becoming more argillaceous towards the top, containing the Buchiola speciosa fauna. Upper 75 feet bluish-black fissile shale. Dip. 90° W.	590	33	479
Direction of run S. 72° W.			
Olive-green fissile shale with occasional bands of blue sandstone	481	32	446
Direction of run N. 50° W.			
Olive-green fissile shale with occasional bands of blue sandstone	431	17	414
Olive-green fissile shale with occasional thin bands of bluish sandstone. N. 30° E. 90° W.	413	48	397
Direction of run N. 85° W.			
Bluish-green fissile shale with an occasional band of sandstone near the bottom. Containing the *Buchiola speciosa* fauna	363	46	349
Direction of run N. 45° W.			
Fissile bluish-green shale, in some places becoming almost black, resembling the Genesee, with thin bands of blue sandstone 2 to 3 inches thick. N. 27° E. 90° W.	313	47	303
Olive-green thin-bedded shale with a few thin beds of blue sandstone 2 to 3 inches thick	263	44	256

Direction of run N. 85° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Olive-green thin-bedded shale with a few thin beds of blue sandstone 2 to 3 inches thick	217	62	212
Direction of run N. 55° W.			
Olive green fissile shale with a few thin beds of bluish-green sandstone 2 to 3 inches thick. N. 27° E. 78° W....	154	15	150
Massive dark-gray sandstone	139	3	135
Thin-bedded fissile olive-green shale with some thin beds of bluish-green sandstone 1 to 3 inches thick	136	31	132
Genesee Black Shale Member			
Very fissile black shale carrying Genesee fauna from top to bottom. N. 25° E. 78° W..........................	104	101	101
Romney-Jennings contact	0		0

The thickness of the lower members is seen to be much less than in the eastern sections, the Chemung fauna appearing 1250 to 1300 feet above the base of the Jennings. Particularly noticeable is the profusion of *Dalmanella tioga* in the lower Chemung, in contrast with the almost entire absence of this genus in the sections east of Wills Mountain.

XXII. Section on Jennings Run Road

The upper Chemung conglomerate and the overlying strata are well exposed on the road leading from Cumberland to Barrelville along Jennings Run. (This section is described by Prosser, supra.)

XXIII. Section near Allegany Grove [1]

A section embracing nearly the entire Jennings is exposed in the cuts of the Cumberland and Pennsylvania Railroad southwest of Allegany Grove. The section begins at the center of the trestle work over the Winchester Road, which leads southwest to Cresaptown, and extends westward 3433 feet, ending at the east end of the first tunnel.

[1] Measured by pacing.

CATSKILL FORMATION

Railroad N. 35° W.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
East end of tunnel	3433		
Interbedded red and green sandstone and red shale. Dip 62° W	3433	33.2	
Red arenaceous shale and some thin-bedded green sandstone	3393	24.9	
Reddish-brown arenaceous shale and some green shale	3363	29.2	
JENNINGS FORMATION			
Chemung Sandstone Member			
Jennings-Catskill contact	3328		2984
Green hackly shale. Dip 72° W	3328	16.6	2984
Concealed in part. Arenaceous green shale and brown sandstone fragments. At 3292 horizontally (2957 vertically) occur *Camarotœchia contracta* abundant, *Spirifer disjunctus* abundant, *Leptodesma* sp. At 3268 horizontally (2941 vertically) occur *Athyris angelica*, *Camarotœchia contracta* abundant, *C. eximia* common, *Spirifer disjunctus* abundant	3308	32.5	2967
Grayish-green and brown sandstone. Dip 48° W	3258	6.5	2935
Arenaceous green shale and thin-bedded green and brown sandstone	3248	33.7	2928
Fissile shale and thin beds of sandstone	3198	13.4	2894
Massive grayish-green sandstone	3178	4.6	2881
Grayish-brown sandstone and a little interbedded shale	3171	8	2876
Massive conglomerate	3159	1	2868
Green and brown interbedded shale with a bed of thin-bedded sandstone at the top	3157	64	2867
Concealed. A massive conglomerate sandstone occurs at 2990 horizontally (2756 vertically). About 2800 vertically occur *Spirifer disjunctus*, *Grammysia elliptica*, *Leptodesma* sp	3062	94.5	2804
Railroad N. 59° W.			
Concealed	2922	199.2	2710
Second-class road crosses railroad	2722		2510
Green and brown arenaceous shale with several beds of brown sandstone 1 foot thick. Loose fragments of conglomerate on hillside on strike of top of this unit. Approximate position of upper Chemung conglomerate 2510 to 2520	2722	90.6	2510
Brown sandstone	2632	3.9	2420

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Brown arenaceous shale	2628	6.9	2416
Brown sandstone heavy bedded near top, thinner bedded below. Dip 90° W	2621	9.9	2409
Arenaceous brown shale, a thin bed of green sandstone at the top. Some interbedded green shale	2611	17.8	2399
Arenaceous green shale. Near top of unit occur *Spirifer disjunctus* abundant, *Cypricardella gregaria* var., *Schizodus oherni*, *Trochonema* (*Gyronema*) sp	2593	14.8	2381
Road N. 89° W.			
Grayish-brown sandstone. Dip 88° W	2578	18	2367
Fissile green shale with thin bed of brown sandstone and a heavy bed of brown sandstone near middle. Near top of the unit occur *Spirifer disjunctus*, *Leptodesma agassizi* ?	2558	19	2349
Grayish-brown sandstone and some interbedded shale containing at 2508 horizontally (2307 vertically) *Douvillina cayuta*, *Spirifer disjunctus*, *Leptodesma medon* common, *L.* sp. About 2320 vertically are found *Schuchertella chemungensis*, *Spirifer disjunctus*, *S.* (*Delthyris*) *mesacostalis*, *Cypricardella cumberlandiæ*	2536	25.4	2330
Grayish-green and brown shale and some thin beds of brown sandstone. Dip 70° W	2506	36.5	2305
Concealed	2463	43.7	2268
Green and red shale. Some brown sandstone in beds 6 inches thick. About 2215 vertically occur *Atrypa spinosa*, *Leptodesma medon* abundant, *L.* sp	2413	113.6	2224
Red and green shale and red sandstone. At 2277 horizontally occurs *Leptodesma* sp. At top occur *Douvillina cayuta*, *Spirifer* (*Delthyris*) *mesacostalis*	2283	34.8	2111
Brown and green shale, carrying at top *Ambocœlia umbonata* abundant, *Chonetes scitulus* abundant, *C. oaklandensis* abundant, *Douvillina cayuta* abundant, *Schuchertella chemungensis*, *Schizophoria striatula* var. *marylandica*, *Leptodesma* sp	2243	6.2	2076
Brown sandstone		6.3	2070
Brown and green shale		9	2063
Brown sandstone		1	2054
Brown and green fissile shale		6.3	2053
Thin-bedded brown sandstone		2.7	2047
Fissile green shale	2207	13	2044
Massive conglomeratic sandstone. Lower beds gray and brown. Upper beds massive, brown	2192	17	2031

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Arenaceous green shale with three beds of greenish-brown sandstone in lower half. About 2000 vertically were found *Douvillina cayuta*, *Schuchertella chemungensis*. About 2020 vertically were found *Camarotœchia eximia*, *Douvillina cayuta* abundant, *Schizophoria striatula* var. *marylandica*, *Spirifer* (*Delthyris*) *mesacostalis*, *Leptodesma medon* common	2172	42	2014
Concealed	2124	164.3	1972
Fissile olive-green shale and interbedded bands of sandstone, all weathering yellow. Occasional beds of red shale. A fine-grained conglomerate 18 inches thick occurs at 1832 horizontally (1720 vertically). About 1750 vertically were found *Chonetes oaklandensis*, *Douvillina cayuta*, *Schuchertella chemungensis*, *Cypricardella gregaria* var. About 1700 vertically *Leptodesma* sp. was found on upper railroad	1936	175	1808
Railroad N. 62° W.			
Green fissile shale, containing at top *Schuchertella chemungensis*, *Spirifer* sp. *Aviculopecten* ? sp., *Grammysia elliptica*, *Leda diversa* ?, *Palæoneilo* sp., *Sandbergeroceras chemungensis* ?	1736	60.4	1633
Massive coarse gray sandstone. At about this horizon the *Tropidoleptus carinatus* fauna was found on a hillside, one-half mile southwest of this section	1671	3.7	1572
Fissile green shale and some interbedded sandstone. At 1516 horizontally (1427 vertically) a massive sandstone occurs, and at 1426 horizontally (1343 vertically) a conglomeratic sandstone. At about 1400 vertically *Cypricardella marylandica* ? small was found and at 1363 vertically *Spirifer disjunctus*	1667	258.5	1569
Green fissile and hackly shale and thin beds of sandstone. Dip 70° W. contains at top *Ambocœlia umbonata* abundant, *Camarotœchia* sp., *Spirifer* (*Delthyris*) *mesacostalis* abundant. About 1250 vertically occur *Ambocœlia umbonata* abundant, *Spirifer* (*Delthyris*) *mesacostalis* abundant. At bottom occur *Ambocœlia umbonata* abundant, *Spirifer* (*Delthyris*) *mesacostalis* abundant	1390	155	1310
Parkhead Sandstone Member			
Concealed. 19 feet of thick yellowish-green argillaceous shale forms top of this unit on upper railroad	1224	126.9	1155

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Olive-green shale and thin beds of sandstone, all weathering yellow. Dip 73° W. At about 950 vertically was found *Atrypa spinosa*, *Grammysia subarcuata*	1089	166	1028
Argillaceous green shale and thin beds of sandstone below, thicker bed of sandstone above. All weathering yellow. Containing in cut on upper railroad at a horizon near top of this unit *Camarotœchia congregata* var. *parkheadensis*, *Cyrtina hamiltonensis*, *Liorhynchus mesacostale* abundant, *Schuchertella chemungensis*, *Productella lachrymosa* ?, *Spirifer* (*Delthyris*) *mesacostalis* ?, *Pterinea chemungensis*	914	124.5	862
East end of first cut west of Winchester bridge	782		738
Woodmont Shale Member			
Concealed. Fissile olive-green shale, exposed on upper railroad	782	37.5	738
Olive-green and yellow shale and thin beds of flaggy sandstone	742	225.7	701
Yellow shale breaking somewhat irregularly. At the top of this unit were found loose *Ambocœlia umbonata*, *Chonetes* sp. It is doubtful whether these fossils were in place	502	30	475
Railroad N. 73° W.			
Olive-green shale and thin bands of greenish sandstone, all weathering yellow. At top of this unit *Camorotœchia* sp. was found loose, but it is doubtful whether it was in place	470	311.7	445
Concealed	140	133	133
Center of trestle over Winchester road. Approximate position of the Romney-Jennings contact................			0

ROMNEY FORMATION

The presence of the Parkhead member is shown by the occurrence of a number of its characteristic species and by a slight development of sandstone, which may represent approximately the upper conglomerate of that member. The percentage of sandstone is, however, so slight as

scarcely to distinguish this portion of the section from the strata of the Woodmont shale member. The Chemung fauna appears 1250 to 1300 feet above the base of the section. An important feature of this section is the recurrence of the Tropidoleptus fauna 1670 feet west of the beginning of the section. The fauna was not seen in the section but was collected on the strike of this horizon ½ mile southwest of the section where the following species were observed: *Ambocœlia umbonata, Spirifer marcyi* var. *superstes, Spirifer* (*Delthyris*) *mesacostalis* and *Tropidoleptus carinatus.*

XXIV. Section near Keyser, West Virginia

The upper beds of the Chemung are finely exposed on the Keyser-Piedmont Road south of the Baltimore and Ohio Railroad 1½ miles west of Keyser, West Virginia. The most conspicuous feature of the section is the occurrence of conglomerates at many horizons in the upper part of the Chemung, as shown by the following section.

CATSKILL FORMATION

Red shale and sandstone. A gray sandstone 5 feet thick occurs 78 feet horizontally (50 feet vertically) above base.

JENNINGS FORMATION *Chemung Sandstone Member* Road N. 71° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Sandstone and shale. Gray prevails, some beds red. Fossils at 2312 horizontally (2870 vertically)	2390	218.6	2920
Sandstone and shale. Dip at top 40° W	2050	75.5	2707
Signal tower. Mile post on B. & O. R. R. marked B. 203 W. 176	1942		
Sandstone and shale	1942	31.1	2626
Road N. 68° W.			
Sandstone and shale. N. 32° E. 50° W	1900	95.5	2595
Sandstone and some shale. A conglomerate 3 feet thick at top containing flat pebbles (Upper Chemung Conglomerate)	1776	22.9	2500

[1] Measured by tape.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Shale and sandstone	1747	15.6	2477
Shale and sandstone. A fine-grained conglomerate 2 feet thick at top	1726	9.5	2461
Shales. A conglomerate 2 feet thick at top	1714	4	2452
Sandstone	1709	19.3	2448
Shale. A sandstone 3 feet thick at bottom. N. 33° E. 52° W	1696	15.6	2428
Shale	1675	73.6	2413
Sandstone. A conglomerate at top	1583	32	2339
Shale and sandstone	1543	56.8	2307
Shale and sandstone. Slightly conglomeratic at top	1472	15.2	2250
Shale and sandstone. Slightly conglomeratic at top	1453	25.6	2235
Conglomerate	1421	6.4	2210
Sandstone	1413	33.6	2203
Chiefly shales	1371	36.8	2170
Coarse sandstone with interbedded shales, a few pebbles at top	1325	15.2	2133
Chiefly shale	1306	60	2118
Sandstone. N. 28° E. 53° W	1242.3	1.2	2058
Shale	1240.8	1.5	2056
Fine-grained conglomerate	1239	3.2	2055
Shale	1235	44.6	2052
Concealed	1180	393.6	2007
Concealed in part. At the top of this interval is a massive green and gray sandstone 20 feet thick, overlain by a massive brown and gray conglomeratic sandstone 14.6 feet thick, containing flattened pebbles, seen on the hillside south of road. N. 43° E. 58° W	700	153	1614
Massive brown and gray conglomeratic sandstone 20.6 feet thick containing round and flat pebbles, seen on hillside south of road. N. 31° E. 60° W	520	20.6	1461
Turn of wagon road, 1942 feet east of signal tower, opposite mile-post 203 of B. & O. R. R	0		

The Jennings is exposed throughout the center of the Oakland anticline. Most of the exposures, however, are of such a character that it is impossible to make satisfactory stratigraphic measurements of them so that while abounding in fossils, the stratigraphy of this part of the Jennings is but poorly known.

XXV. Section on Middle Fork[1]

The best section observed in the Oakland area is on the Middle Fork of the Savage River 2 miles on an air line northwest of Floyd Station on the Baltimore and Ohio Railroad, from which point this section is best reached. It begins on the county road leading from Frankville (Floyd), 300 feet east of the point where the road crosses Middle Fork northeast of Chestnut Knob. It ends in the center of the anticline at the mouth of the first run that enters Middle Fork from the northeast east of Blackhawk Run. The base of the Chemung member is not exposed in this section.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
CATSKILL FORMATION			
Road N. 75° W.			
Section begins on county road 300 feet east of point where it crosses Middle Fork	0		0
Red sandstone (concealed in part). A massive gray sandstone perhaps 20 feet thick occurs at top bearing a band of conglomerate, fragments of which are found on hill north of road. N. 32° E. 16° E	300	74	95.6
Road crosses stream. Section is continued beyond this point along Middle Fork Run. Altitude 1640	300		95.6
Direction of run due north.			
Concealed. In part red sandstone and shale	520	45	119
Concealed	680	32	151
Red arenaceous shale with one band of gray-green sandstone near bottom 1 foot 4 inches thick, N. 42° E. 15° E.	880	38	189
JENNINGS FORMATION			
Chemung Sandstone Member			
Largely concealed	1020	28	217
Direction of run N. 35° W.			
Largely concealed	1120	29	245
Thin-bedded gray sandstone. N. 45° E. 17° E	1260	30	276
Concealed	1370	50	326
Gray thin-bedded sandstone, N. 32° E. 19° E., N. 28° E. 19° E	1550	25	351

[1] Measured by pacing.

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Thin-bedded gray-green sandstone, heavy bed at top containing fossils. N. 48° E. 16° E.	1720	40	391
At 1920 to 1960 massive sandstone 11 feet thick. N. 36° E. 16° E. 1960. Dip 37° E. At 2000 a sandstone 2 feet thick. Dip. 21° E.	2240	123	514
Direction of run N. 75° W.			
Concealed	2300	15	529
Catskill-Jennings contact as given on map in Grantsville-Accident folio	2300		529
Thin-bedded brown sandstone. N. 35° E. 16° E. at 2320.	2350	13	542
Concealed. N. 30° E. 18° E.	2390	11	553
Interbedded brown and gray arenaceous shale and sandstone. N. 25° E. 19° E.	2490	32	585
Concealed	2540	14	599
Direction of run N. 35° W.			
Concealed. The road crosses stream at 2820.	2910	72	671
Thin-bedded gray and brown sandstone. N. 30° E. 15° E. and N. 36° E. 16° E.	3100	42	713
Concealed	3290	42	755
Direction of run N. 53° W.			
Concealed	3590	67	822
Direction of run N. 68° W.			
Concealed	3700	34	856
Heavy brown sandstone. Brown arenaceous shale at top. Dip 14° E.	3720	5	861
Concealed	3960	37	898
Massive gray conglomeratic sandstone. N. 39° E. 10° E.	3975	2	900
Massive grayish-brown sandstone. N. 31° E. 10° E.	4065	14	914
Thin-bedded gray sandstone, interbedded brown shale and gray arenaceous shale. Dip 10° E.	4215	23	937
Concealed	4355	22	959
Gray thin-bedded sandstone. 10° E.	4395	6	965
Concealed. Dip 10° E.	4455	9	974
Thin-bedded gray sandstone. Dip 13° E.	4490	6	980

Direction of run N. 89° W.	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Thin-bedded gray sandstone, some interbedded arenaceous shale at bottom. N. 21° E. 10° E., N. 21° E. 12° E., N. 25° E. 10° E.	4635	21	1001
Grayish-brown sandstone. Some interbedded arenaceous shale. Sandstones thin-bedded. Heavy beds at top and bottom	4835	29	1030
Concealed	5055	14	1044
Alternating thin and heavy beds of brown sandstone with some interbedded brown shale. N. 27° E. 6° E., N. 12° E. 5° E. Dip 5° E.	5235	12	1056
Concealed. A conglomerate at approximately 5325 Loose fragments probably in place on hillside. The upper Chemung conglomerate. Altitude 1720 on map	5325	6	1062
Concealed	5610	38	1100
Direction of run N. 69° W.			
Concealed	5735	18	1118
Concealed. Old saw mill	5835	14	1132
Concealed	5895	8	1140
Thin-bedded gray sandstone. Dip 8° E.	5935	4	1144
Heavy-bedded brown sandstone with interbedded brown thin-bedded sandstone. Gray hackly shale at top. Dip 7° E	5995	6	1150
Interbedded brown sandstone and gray hackly shale. Dip 5° E.	6165	14	1164
Thin-bedded brown sandstone. A few heavier beds. Dip 12° E.	6285	22	1185
Fifty feet from top. Dip 23° E. Concealed	6585	42	1228
Thin-bedded brown sandstone. Dip 55° E.	6605	16	1224
Concealed. Dip 40° E. 40 feet from top	6655	31	1275
Heavy thin-bedded brown flaggy sandstone. Dip 10° E.	6695	5	1280
Concealed	6760	8	1288
Direction of run N. 11° W. Altitude 1750 on map			
Concealed. Massive sandstone 2 feet thick opposite house. Dip 6° E.	6795	2	1290
House	6795		1290
Thin-bedded gray sandstone. Dip 6° E.	6825	1	1291
Concealed	6925	10	1301
Thin-bedded gray sandstone and interbedded gray-green arenaceous shale. Dip 16° E. Dip 12° E.	6955	18	1319
Thin-bedded brown sandstone and interbedded brown shale breaking into pieces. Dip 24° E.	7075	5	1324

	Horizontal distance from beginning of section to top of beds	Thickness	Altitude of top of beds above base of Jennings
Concealed	7115	4	1328
Massive brown sandstone. Dip 3° E.	7122	1	1329
Concealed	7202	8	1337
Massive and thin-bedded brown flaggy sandstone. Dip 15° E.	7372	26	1363
Concealed. At 7770 Dip 70° E.	7840	46	1409
Direction of run N. 35° W.			
Concealed. Dip 85° W. at 7850	8072	31	1440
Grayish-green sandstone anticline. Dip 3° E. 3° W. 10° E.	8202	10	1450
Largely concealed	8402	26	1476
Concealed. A massive sandstone and shale about 10 feet thick about 75 feet above base of the unit. Dip 20° E.	9170	101	1577
Direction of run N. 19° W.			
Concealed	9202	4	1581
Grayish-green thin-bedded sandstone with thin-bedded brown sandstone at bottom, average dip taken 9° E. 18° E. Dips 24° E., 14° E., 8° E., 0° E., 8° W.	9442	23	1604
Largely concealed	9522	9	1613
Thin-bedded gray sandstone. Dip 40° E.	9562	19	1632
Concealed	9582	3	1635
Heavy-bedded gray-green sandstone. Dip 8° E.	9592	1	1636
Concealed	9742	17	1653
Thin-bedded grayish-green sandstone and interbedded grayish-green arenaceous shale with a few heavy beds of sandstone. Dips 2° E., 5° E., 7° E., 15° W. Average dip 18° E.	10112	81	1734
Green and brown thin-bedded flaggy sandstone and interbedded brown and green hackly shale	10312	10	1744
End of section at ravine from north. Center of anticline. Altitude 1840	10312		1744

This section has not been studied faunally. It affords, however, a valuable estimate of the thickness of the strata in this area. Conglomerates occur at three horizons. The lower of these is not well seen in the section but is conspicuous on top of the hill at the center of the anticline about 750 feet vertically above the point where the section ends.

This is the most conspicuous conglomerate in the Oakland anticline and develops a series of knobs where it outcrops. It has been described by Prosser as the Avilton conglomerate and is probably the same as the upper conglomerate of the preceding sections. A less conspicuous conglomeratic sandstone occurs 162 feet vertically above the preceding. A third conglomeratic sandstone occurs at the top of the section 900 feet above the lower conglomerate and develops a conspicuous series of hills in the region. It is underlain by red strata of Catskill type.

The Jennings-Catskill contact was placed by Prosser 50 feet above the upper conglomerate in this section. The writer prefers to place it at the base of the red stratum found beneath the upper conglomerate because of the Catskill-like character and considerable thickness of the red stratum, the slight thickness of the upper gray beds associated with the conglomerate, and the absence of observed marine fossils above the horizon suggested. Similar gray beds are not infrequent in the lower part of the Catskill in the eastern sections.

SYSTEMATIC PALEONTOLOGY

OF

THE UPPER DEVONIAN DEPOSITS OF MARYLAND

BY

JOHN M. CLARKE

AND

CHARLES K. SWARTZ

SYSTEMATIC PALEONTOLOGY

UPPER DEVONIAN

COELENTERATA ....JOHN M. CLARKE and C. K. SWARTZ.
ECHINODERMATA ....JOHN M. CLARKE and C. K. SWARTZ.
VERMES ....JOHN M. CLARKE and C. K. SWARTZ.
MOLLUSCOIDEA.
    BRACHIOPODA ....JOHN M. CLARKE and C. K. SWARTZ.
MOLLUSCA.
    PELECYPODA ....JOHN M. CLARKE and C. K. SWARTZ.
    GASTROPODA ....JOHN M. CLARKE and C. K. SWARTZ.
    CEPHALOPODA ....JOHN M. CLARKE and C. K. SWARTZ.
ARTHROPODA.
    TRILOBITA ....JOHN M. CLARKE and C. K. SWARTZ.
    OSTRACODA ....JOHN M. CLARKE and C. K. SWARTZ.
VERTEBRATA.
    PISCES ....CHARLES K. SWARTZ.

COELENTERATA

Class ANTHOZOA

Subclass TETRACORALLA

Family ZAPHRENTIDAE

Genus ZAPHRENTIS Rafinesque

ZAPHRENTIS MARYLANDICUS n. sp.

Plate XLV, Figs. 1, 2

Description.—Corallite simple, slightly curved, conical, diameter increasing a little more rapidly toward apex. Exterior showing indistinct septal furrows and slight irregular annular constrictions. Calyx shallow in proportion to length of corallite, width usually exceeding depth; its bottom wide, often flat, sides erect, edges thin. Septa about 80 in larger specimens, alternating in length, usually but not always reaching center, appearing as ridges upon bottom of calyx. Fossette deep, on convex side of calyx. Tabulæ unknown.

Length of corallite 55 mm.; diameter of calyx 27 mm.

This species differs from *Z. chemungensis* in (1) larger size, (2) more distant septa, (3) calyx proportionally much shallower. It is known only by casts of calyx and exterior, hence its generic position is not assured. Although its interior structure is not known, the perfect preservation of the interior of its calyx renders it worthy of a specific name.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road on Polish Mountain, 2706,[1] abundant.

Collection.—Maryland Geological Survey.

[1] The numbers after localities indicate the stratigraphic altitude above the base of the Jennings formation.

ZAPHRENTIS CHEMUNGENSIS n. sp.

Plate XLV, Figs. 3-6

Description.—Corallite simple, conical, curved. Exterior bearing shallow annular constrictions placed at irregular distances, striated longitudinally by septal furrows. Calyx very deep in proportion to length of corallite, occupying much of interior of corallite; its bottom concave, sides spreading, edges thin. Septa about 60 to 65, alternating in length, the longer reaching center of calyx. Septal fossette deep, situated on convex side, containing a long cardinal septum.

Length of corallite about 20 mm.; diameter of calyx 17 mm.

This species differs from *Z. marylandica* in (1) smaller size. (2) closer septa, (3) great depth of calyx. This species is known only by casts of its exterior and calyx, so that its generic position is not assured. While it seems hazardous to erect a new species in the genus *Zaphrentis* upon such material yet the perfect preservation of the casts of the calyx renders it desirable to have some specific name by which the form may be distinguished.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road on Polish Mountain, 2706, abundant.

Collection.—Maryland Geological Survey.

Family CYATHOPHYLLIDAE

Genus HELIOPHYLLUM Hall

HELIOPHYLLUM SCRUTARIUM n. sp.

Plate XLV, Figs. 7, 8

Description.—Corallum small, frequently budding; individual corallites rather short, slender, cupshaped; surface highly rugose, irregular. Calyx moderately deep, bearing numerous septa, those of all orders bearing the lateral carinations and the denticulate edges which characterize the genus *Heliophyllum*.

Several specimens of this coral occur as casts in the same decomposed sandstone as that bearing the *Favosites* described next following. Our

characterization of them is therefore restricted to exterior features, but the species is recognizable from its small and easily branching corallum. Species of *Heliophyllum* occur elsewhere in the Chemung fauna but forms of the expression of *H. scrutarium* are not known to the writer.

Length of corallite 10-20 mm.; diameter 8-10 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG ? MEMBER. On Sideling Hill Creek, Allegany County.

Collection.—Maryland Geological Survey.

Subclass HEXACOROLLA

Order MADREPORIA

Suborder TABULATA

Family FAVOSITIDAE

Genus FAVOSITES Lamarck

FAVOSITES sp.

Plate XLV, Fig. 9

Description.—Fragments of a rather slender branching form of *Favosites* occur as casts in the sandstone and consequently only the aspect of their exterior is evident. As corals are unusual in sediments of this age these specimens are worthy of note inasmuch as the characters shown suffice to permit their recognition when found elsewhere. In general the specimens may be compared to the branching middle Devonian species ***Favosites arbusculus*** Hall (Hamilton, New York), but the stock and branches are more slender. This stock is essentially cylindric, tapers very slowly, undulates in growth and branches with irregularity. The cell apertures are oblique, polygonal and almost devoid of interstitial cellules.

Diameter of corallum 6-8 mm.; diameter of corallites about 1 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG ? MEMBER. On Sideling Hill Creek, Allegany County.

Collection.—Maryland Geological Survey.

Family AULOPORIDAE

Genus AULOPORA Goldfuss

AULOPORA REPENS Knorr & Walch

Plate XLV, Figs. 10, 11

Melliporites repens Knorr et Walch, 1775, Rec. des mon. catastr. t. iii, p. 157, sup. pl. vi, fig. 1.

Aulopora serpens Goldfuss, 1829, Petref. Germ., vol. i, p. 82, pl. xxix, fig. 1.

Aulopora repens Milne-Edwards and Haime, 1857, Polyp. Foss. des Terr. Pal., p. 312.

Aulopora serpens Rominger, 1876, Geol. Surv. Mich., vol. iii, p. 87, pl. xxxiii, fig. 2.

Aulopora serpens Cleland, 1911, Bull. xxi, Wisconsin Geol. Surv., p. 34, pl. ii, fig. 4.

Description.—Corallum tabular, prostrate; branching from buds which originate below calyx; dichotomous, or branches anastomosing to produce a loose meshwork. Branches funnel-shaped, attached throughout their length to other organisms, especially to brachiopods. Calyx funnel-shaped, directed upwards. Tabulæ and septa absent.

Diameter of branches at calyx 2 mm.; at base 1 mm.; length of branches 3-5 mm.

This appears to be the same species as one which occurs in the Hamilton formation of New York and which has usually been described as *Aulopora serpens* Goldfuss. Its identity with the European species, however, is open to question.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. 2½ miles southeast of Cumberland.

Collection.—Maryland Geological Survey.

Genus CLADOCHONUS McCoy

CLADOCHONUS HUMILIS n. sp.

Plate XLVI, Figs. 1, 2

Description.—Corallum tubular, prostrate, branching dichotomously. Branches ascending, funnel-shaped, gradually increasing in diameter from origin to calyx. Interior of tube set with delicate spinules which are arranged in lines in some parts, in others irregularly disposed. Tabulæ and septa none. Exterior showing delicate transverse striæ.

Diameter of branches at calyx 2 mm.; at base 1 mm.; length of branches 5-7 mm.

This genus differs from *Aulopora* in that the branches are not attached inferiorly to other objects but are in large part free. This is probably the same species as one usually described as *Cladochonus* sp. which occurs in the Ithaca of New York. Very abundant in the Ithaca fauna, rare in the Chemung of Maryland.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Ellerslie, 1316. WOODMONT MEMBER, ITHACA FAUNA. Hancock 690, 994; Hancock-Harrisonville Road, 2 miles northeast of Hancock, 726, abundant; Berkeley Springs, West Virginia, 755, 825, abundant.

Collection.—Maryland Geological Survey.

ECHINODERMATA

CLASS ASTEROIDEA

Subclass ENCRINASTERIAE

Genus PALAEASTER Hall

PALÆASTER CLARKI n. sp.[1]

Plate XLVI, Figs. 3, 4

Description.—This species is represented in the collections by a single specimen affording a pretty sharp cast of both sides of a very regular and complete individual. In general structure and appearance the species is quite similar, especially on the oral surface, to *Palæaster eucharis* Hall of the sandy Hamilton shales of central New York, but the latter is a much larger form.

The disk is small, rays long and slender, thecal plates all prominently developed. The ambulacral surfaces are represented only by a narrow linear depression beneath which the ambulacral plates are concealed. These depressions are bordered by thickened and somewhat elevated quadrangular or pentangular adambulacra. The marginal plates are in

[1] Thus named, as a supererogatory tribute to Prof. W. B. Clark.

single rows, much thickened, with generally quadrangular outline and convex surface, each projecting on the margin of the ray. At each axilla is a single pear-shaped plate with its apex outward, these plates being the largest in the individual. The abactinal surface is tessellated by rows of strong convex plates of similar size to the marginal plates. Of these there are three rows, a median row of narrow oval ones between the ends of which are interlocked the edges of the much larger plates of the lateral rows which are highly convex and thickened in the center and greatly depressed to the sutures. Thus each plate has a cushioned surface. Between the ends of each plate of the middle row are two minute accessory plates lying in the angles at which the lateral plates enter. At the base of each ray and upon the disk is a single large plate whose surface rises into a high clavate node. Between each two of these is one of less height. The central portion of the aboral area is destroyed and no trace of madrepore is seen.

The width of this specimen from tip to tip is 33 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Yellow sandstone on the road northeast of Oakland, Garrett County, where it is associated with *Spirifer disjunctus.*

Collection.—Maryland Geological Survey.

VERMES

CLASS ANNELIDA

Subclass CHAETOPODA

Order POLYCHAETA

Suborder TUBICOLA

Genus SPIRORBIS Lamarck

SPIRORBIS GYRUS n. sp.

Plate XLVI, Fig. 5

Description.—Tube closely coiled, attached by one side of all the whorls, the final whorls not becoming lax. Volutions 2-3, ascending on

the free surface. On the early whorls the upper outer edge is angulated and bears a row of sharp oblique tubercles, but in final growth this angulation disappears and rounded tubercles are irregularly scattered over the whole surface.

The species bears much resemblance to *Sp. angulatus* Hall (15th Ann. Rept. N. Y. State Cab. Nat. Hist., p. 112, 1862) from the Hamilton shales of New York, but while that species is tubercled the growth is often irregular and the later whorls are lax and free.

Diameter 4 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG ? MEMBER. On Sideling Hill Creek, Allegany County.

Collection.—Maryland Geological Survey.

SPIRORBIS sp.

Description.—Casts of a small Spirorbis have been observed in the Parkhead that do not show exterior ornamentation. Their condition does not permit confident specific determination.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Two miles north of mouth of Town Creek, 1723.

Collection.—Maryland Geological Survey.

INCERTAE SAEDIS

Genus PTERIDICHNITES n. gen.

Fern-like imprints consisting of two rows of small pits bordered by a narrow elevated margin and separated by narrow transverse ridges. Pits nearly equidimensional. The nature of these objects is problematical. They are probably tracks of crustaceans or possibly of annelids. The tracks suggest those referred to the genus *Nereites,* but are not sinuous. (From *Pteris* a fern, *ichnos* a track.)

PTERIDICHNITES BISERIATUS n. sp.

Plate XLVI, Fig. 6

Description.—Imprints consisting of two parallel grooves with raised borders, divided by narrow transverse ridges into shallow, nearly square

or slightly rounded pits, which commonly alternate in position. The median ridge dividing the two grooves is not straight but is crenulated by slight inflections directed toward the transverse ridges. Length and width of pits subequal. The impressions usually become faint toward their ends and are often curved.

Width of track about 4 mm., diameter of pits about 2 mm. Tracks are several centimeters long. Similar tracks are abundant in the beds containing the Naples fauna in New York.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, NAPLES FAUNA. Tonoloway.

Collection.—Maryland Geological Survey.

MOLLUSCOIDEA

CLASS BRACHIOPODA

Order ATREMATA

Superfamily LINGULACEA

Family LINGULIDAE

Genus LINGULA Bruguière

LINGULA OHERNI n. sp.

Plate XLVII, Figs. 1-5

Description.—Shell ovate-elliptical, slightly convex; width two-thirds to three-fourths length, greatest width slightly anterior to middle of valve. Cardinal slopes rounded, sides diverging slightly to a point in front of middle, anterior margin rounded. The shape of the cardinal margin is variable, in some cases forming an acute angle or in others being truncate. Surface marked by fine concentric striæ. A fine impressed line extends from center of umbo a part of the length of the valve in some individuals. Shell substance thin.

Length of larger individuals 8 to 12 mm.; width 6 to 9 mm.

This species resembles *L. delia* of the Hamilton of New York, but is smaller, proportionally wider, its cardinal slopes not abrupt. It differs

from *L. ligea* and *L. melie* in its more ovate form. Associated with the larger shells are many smaller individuals which are considered the young of this species. They are less ovate, not being much if any wider in front, a feature shown to be characteristic of the young individuals by the concentric lines on the older shells. This species is locally abundant in the western sections at the base of the Parkhead member.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Williams Road east of Cumberland, 1393, abundant; 2¼ miles southeast of Cumberland; road 1 mile north of Rocky Run, West Virginia.

Collection.—Maryland Geological Survey.

LINGULA LIGEA Hall

Plate XLVII, Figs. 6, 7

Lingula ligea **Hall, 1860, 13th Rept. N. Y. State Cab. Nat. Hist., p. 76.**
Lingula ligea **Hall, 1867, Pal. of N. Y., vol. iv, p. 7, pl. i, fig. 2.**
Lingula ligea **var. Hall, 1867, Pal. of N. Y., vol. iv, p. 8, pl. ii, fig. 8.**
Lingula ligea **Grabau and Shimer, 1909, N. Amer. Index Fos. vol. i, p. 197, fig. 229.**

Description.—" Shell narrow elliptical; length equal to twice the width; sides regularly curving; extremities subequal; margins of the valves thickened. Surface marked by fine concentric striæ, and by a few obscure or obsolete radiating striæ. The more convex valve shows, along the inner margin, a narrow shallow groove as if the edge of the opposite valve closed just within its margin." Hall, 1867.

The variety is described as " larger, the sides somewhat straighter; while the cardinal extremity is not so rounded, and slopes in nearly a right line on each side of the beak." [1] The individuals observed correspond well with the form described by Hall as *Lingula ligea* var. save that they are somewhat smaller.

Occurrence.—JENNINGS FORMATION, ITHACA FAUNA. Hancock, 1149 to 1274 rare, 1564 to 1599 ? abundant. The latter specimens were found loose on the road. They occur in red sandstone similar to that forming

[1] Pal. of N. Y., vol. iv, p. 8.

the red bed between 1564 and 1599 from which they probably come. Their exact horizon is not assured.

Collection.—Maryland Geological Survey.

LINGULA SPATULATA Vanuxem

Plate XLVII, Fig. 8

Lingula spatulata Vanuxem, 1842, Geol. of N. Y., Rept. Third Dist., p. 168, fig. 3.

Lingula spatulata Hall, 1867, Pal. of N. Y., vol. iv, p. 13, pl. i, fig. 1.

Lingula spatulata Grabau and Shimer, 1909, N. Amer. Index Fos. vol. i, p. 197, fig. 231.

Description.—" Shell small, subspatulate or subelliptical, moderately convex, attenuate towards the beak, the ventral valve being more acute; greatest width across the middle of the shell; length (which is scarcely three-tenths of an inch) about twice as great as the width. Surface marked by fine concentric striæ, and, in the exfoliated shell, by faint radiating striæ." Hall, 1867.

Length 3 mm. width .6 mm.

This is a characteristic species of the Ithaca fauna of New York. It is distinguished by its small size and spatulate shape.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Hancock, 1149 to 1274; Berkeley Springs, West Virginia, 1058.

Collection.—Maryland Geological Survey.

LINGULA sp. ?

Description.—A small species of this genus having the elongate slender form of *L. spatulata* Hall[1] of the Genesee fauna of New York has been found at a single locality, but the specimens are insufficient for exact identification or for illustration.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, NAPLES FAUNA. In the soft olive shales of the lower part of the section on National Road, Polish Mountain.

Collection.—Maryland Geological Survey.

[1] Paleontology of New York, vol. iv, p. 13, pl. i, fig. 1.

Order NEOTREMATA

Superfamily DISCINACEA

Family DISCINIDAE

Genus ORBICULOIDEA d'Orbigny

ORBICULOIDEA cf. MEDIA (Hall)

Plate XLVII, Figs. 9, 10

Discina media **Hall, 1863, 16th Rept. N. Y. State Cab. Nat. Hist., p. 27.**
Discina media **Hall, 1867, Pal. of N. Y., vol. iv, p. 20, pl. ii, figs. 25-29.**
Orbiculoidea media **Hall and Clarke, 1892, Pal. of N. Y., vol. viii, pt. i, pl. iv, figs. 15-17.**

Description.—Shell subelliptical to subcircular. Small. Dorsal valve low conical, umbo excentric, small, acute. Surface with concentric striæ. Interior of dorsal valve and ventral valve not observed. The shell figured is somewhat crushed, causing the umbo to appear more nearly central than it is, and the outline more elliptical than it should be.

This species of which but two individuals have been observed, suggests *O. media* which occurs both in the Hamilton and Upper Chemung faunas of New York. More material is needed to permit confident identification.

Length 7 mm.; width 8 mm.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Williams Road, east of Cumberland, 1393; National Road on Polish Mountain in soft olive shale with *Chonetes lepidiformis.* WOODMONT MEMBER, ITHACA FAUNA. Fifteenmile Creek, 1 mile above mouth, 1446.

Collection.—Maryland Geological Survey.

Superfamily CRANIACEA

Family CRANIIDAE

Genus CRANIELLA Œhlert

CRANIELLA HAMILTONIÆ Hall[1]

Plate XLVII, Figs. 11-13

Description.—Shell transverse conical. Umbo subcentral. Dorsal valve quite convex. Adductor muscular scars pronounced, close together

[1] For synonymy see page 131.

beneath umbo. Posterior muscular scars more widely separated, indistinct in cast observed. Large C-shaped vascular markings near margin. Exterior not observed. Shell substance punctate.

Width 16 mm.; length (antero-posterior diameter) 12 mm.; height 7 mm.

The cast of the interior of a single valve has been observed. While unusually convex it agrees with this species in other respects. The C-shaped markings of the vascular sinus, characteristic of the genus *Craniella,* are observable upon the cast though not shown in the drawing.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Williams Road, Polish Mountain, 1660.

Collection.—Maryland Geological Survey.

CRANIELLA ? sp.

Description.—Shell low conical, subcircular or slightly transverse. Umbo excentric, near posterior margin. Dorsal valve quite convex from umbo to anterior margin, less so to lateral margin, slightly concave to posterior margin. Height of valve variable, about one-fourth diameter or less. Interior of valve shows a pair of indistinct scars beneath umbo for attachment of anterior adductor muscles. Shell substance punctate. Ventral valve not observed.

Diameter 15 to 20 mm.; height 3 to 4 mm.

The identification of these specimens is not assured, the interior not being sufficiently well preserved to permit of confident generic determination. It is not improbable that the species is *C. hamiltoniæ* though much less convex than the other Maryland individuals referred to that species.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Ellerslie, Pennsylvania, 1474, 1508.

Collection.—Maryland Geological Survey.

Genus CRANIA Retz

CRANIA sp.

Description.—A single dorsal or upper valve of this genus has been observed and is insufficient for specific identification. The genus is likewise but sparingly represented in the Chemung fauna elsewhere.

Occurrence.—JENNINGS FORMATION, CHEMUNG ? MEMBER. West slope of Polish Mountain on National Road.

Collection.—Maryland Geological Survey.

Order PROTREMATA

Superfamily STROPHOMENACEA

Family STROPHOMENIDAE

Genus STROPHEODONTA Hall

STROPHEODONTA DEMISSA (Conrad) [1]

Plate XLVII, Fig. 14

Description.—Well-characterized specimens of this species occur not rarely in the Ithaca fauna. A single individual is recorded from the Chemung.

Length 25 mm.; width 30 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Oakland-Altamont Road. WOODMONT MEMBER, ITHACA FAUNA. Two miles west of Pawpaw, West Virginia, 1388; Little Orleans, 1446; Fifteenmile Creek, 1 mile above Little Orleans, 1446; Hancock, 672; Hancock-Harrissonville Road, 882; Berkeley Springs, West Virginia, 712, common; Yellow Springs, West Virginia.

Collection.—Maryland Geological Survey.

STROPHEODONTA MAYNARDI n. sp.

Plate XLVII, Figs. 15-18

Description.—Shell large semielliptical, planoconvex, cardinal extremities long mucronate, hinge-line much longer than width of shell. Ventral valve convex, point of greatest convexity near umbo; surface curving regularly toward front, concave toward cardinal angles. Dorsal valve nearly plane, bearing low radiating fold-like plications. Area narrow, hinge-line crenulated. Surface bears numerous striæ, the direction of

[1] For synonymy and description see page 136.

which differ on cardinal extremities of ventral valve from those on remainder of shell.

Interior of ventral valve with diverging flabelliform scars for diductor muscles, the surface of which is plicate. Adductor muscular scars distinct, divided by an impressed line. Interior of dorsal valve pustulose with well-marked scars for attachment of adductor muscles and a forked cardinal process which is seen in cast as two circular pits.

Length 25 mm.; width 75 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 3398.

Collection.—Maryland Geological Survey.

Genus LEPTOSTROPHIA Hall and Clarke

LEPTOSTROPHIA PERPLANA VAR. NERVOSA (Hall)

Plate XLVIII, Figs. 1-4

Strophomena nervosa Hall, 1843, Geol. of N. Y., Rept. 4th Dist., p. 266, fig. 1.

Stropheodonta perplana var. *nervosa* Hall, 1867, Pal. of N. Y., vol. iv, p. 13, pl. xix, figs. 13-16.

Leptostrophia perplana var. *nervosa* Hall and Clarke, 1892, Pal. of N. Y. vol. viii, pt. i, p. 15, figs. 14, 15, 17.

Description.—Shell very depressed, subplane, gently convexo-concave in the umbonal region. Surface covered with fine radial striæ which are irregularly thickened and give the surface a rough and scraggy appearance. These plications are normally of different orders of size, between each two of equal size there being 3-5 of lesser size, a mode of arrangement of surface markings which is a very ancient feature among these brachiopods. Individuals of this variety show a tendency to irregular thickening of the plications at early growth stages, but in the occasional individual in which it is not well displayed at maturity there is a notable irregularity in the course of the striæ.

The hinge is denticulate and the deltidium very narrow, almost or wholly closed. On the interior the ventral valve presents very broad flabellate muscle scars surrounded by a papillose pallial surface. In the

dorsal valve the cardinal process is strong and deeply bifurcate, supported by thick divergent and papillose ridges which bound the obscurely defined muscle impressions. These shells attain considerable dimensions, are frequently extended on the hinge-line, and show no internal characters which are not normal to the species itself.

The species *Leptostrophia perplana* is one of the flat stropheodontids that makes its appearance early in the Devonian, becoming quite abundant in the Hamilton stage and also occurring with normal characters in the Chemung of New York.

Length 30-35 mm.; width 35-40 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road west of Tonoloway Ridge. This shell seems not to be widely distributed but has been found abundantly in the vicinity of Oakland, Cherry Creek, near Mitchell House on Altamont Road and Deer Park, Garret County.

Collection.—Maryland Geological Survey.

LEPTOSTROPHIA PERPLANA VAR. ALTERNATA n. var.

Plate XLVIII, Figs. 5, 6

Description.—This variety resembles *L. perplana* var. *nervosa* in having nodose striæ and in its muscular scars. It differs from that variety in having alternating coarse and fine striæ and is frequently smaller than the usual size of var. *nervosa.* It resembles *L. interstrialis* in possessing alternating coarse and fine striæ but differs in the more strongly nodose character of the striæ. It seems to be a transitional form connecting these two species.

Length 11 mm.; width 16 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Section on National Road west of Frostburg; Trout Run near Mountain Lake Park; Williams Road on Polish Mountain, 2042 abundant; Town Creek, 2122, 2391 abundant.

Collection.—Maryland Geological Survey.

LEPTOSTROPHIA INTERSTRIALIS (Vanuxem)

Plate XLVIII, Fig. 7

Strophomena interstrialis Vanuxem (non Phillips), 1842, Geol. N. Y., Rept. 3d Dist., p. 174, fig. 1.

Stropheodonta mucronata Hall (non Conrad), 1867, Pal. N. Y., vol. iv, p. 111, pl. xv, figs. 13, 14.

Stropheodonta interstrialis Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, p. 423.

Description.—" Shell semioval, the proportions of length and breadth varying considerably, the hinge-line often extended beyond the width of the shell. The ventral valve is very depressed-convex, and the dorsal valve nearly flat. The area of the ventral valve is extremely narrow, and the inner margin crenulated for about half its length. The surface is marked by distant sharp elevated striæ, with the interspaces occupied by numerous finer undulating striæ. The muscular impressions are faintly marked; those of the occlusor muscles occupy a minute space near the apex of the cast; and the divaricator muscular impressions are elongate and spreading, and partially limited by an oblique pustulose ridge on each side, in form and character like those in *S. perplana,* but less strongly defined. The cardinal process of the dorsal valve is slender, and supported at its base by an oblique ridge on each side, between which the muscular markings are faintly impressed." Hall, 1867.

Length 15 mm.; width 22 mm.

The individuals observed are smaller than those figured by Hall, their coarser striæ are also somewhat nodose while the finer striæ are slightly undulating. They resemble *L. perplana* var. *alternata* from which they differ in smaller size and in having straighter and less nodose striæ. They occur also at a lower horizon. The resemblance to *L. perplana* var. *alternata* is so close in some cases, however, that the separation of this variety from that species is not fully assured.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Hancock-Harrisonville Road, 880; Millstone, 795.

Collection.—Maryland Geological Survey.

Genus DOUVILLINA Œhlert

DOUVILLINA CAYUTA (Hall)

Plate XLVIII, Figs. 8-17; Plate XLIX, Figs. 1, 2

Strophodonta cayuta Hall, 1867, Paleontology of New York, vol. iv, p. 110, pl. xix, figs. 1-5.

Douvillina cayuta Hall and Clarke, 1892, *ibid.*, vol. viii, pt. 1, pl. xv, figs. 18, 19.

Description.—Shell gently convexo-concave in the umbonal region, abruptly deflected toward the front, usually somewhat extended on the hinge; surface with quite regularly alternating surface striæ; the denticulated hinge-line is fully developed on both valves and the deltidium wholly obliterated in the mature condition. The internal casts of the ventral valve show the short but highly pronounced divaricator muscular scars elevated upon a shelly thickening turned up at its anterior edge. Some of these also show at the sides of this scar broad granulated or striated ovarian areas while the pallial area may carry impressions of brachial or irregular sinuses. The brachial valve carries a strong bifurcate cardinal process and is at once to be recognized by the elevated divergent edges of the muscular fulcrum separating the anterior and posterior adductor scars and beneath projecting edges of which the former are sequestered. The species sometimes attains quite commanding proportions and may vary notably in the extension of the cardinal area.

This peculiar shell is one of the most abundant of the Maryland Chemung fossils. At certain localities it occurs in masses and almost to the exclusion of other organisms. This abundance is in very marked contrast to its occurrence in more northerly localities of the Appalachians, for in New York the shell is seldom abundant and above the lower beds of the series in the western central region it is comparatively rare. Some specimens from section on Oakland-Altamont Road differ from the others in having striæ somewhat fasciculate and in possessing a slightly angular median fold.

It is useful to separate from the species a small shell of persistent habit which differs from the somewhat variable specific form in features to be directly pointed out. While in New York shells referred

to the species at present include forms of small size in the middle and upper horizons of the Chemung it is not certain that such small shells are of the same local type as these here termed var. *graciliora*.

Length 25 mm.; width 45 mm.

This species occurs profusely west of Wills Mountain, rarely east of that locality.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road west of Frostburg; Oakland-Altamont Road; Oakland-Redhouse Road; Trout Run near Mountain Lake Park; Deer Park; Green Glade Run; Bear Run (Savage River); Allegany Grove, 1750, 2000, 2020 abundant, 2050, 2076 abundant, 2111, 2307; Ellerslie, Pennsylvania, 1316, 1474 common, 1508; National Road on Polish Mountain, 2706 ?; Town Creek, 3584, 3942.

Collection.—Maryland Geological Survey.

DOUVILLINA CAYUTA VAR. GRACILIORA n. var.

Plate XLIX, Figs. 3-13

Description.—The prevalent size of this small variety is shown on several crowded slabs where all the individuals are of about the same proportions and maintain diminutive dimensions while presenting in their full development the characters of *D. cayuta.* These shells are more convex than the larger form, the pallial region descending abruptly from about the middle part of the ventral valve, while behind the ridge of this curvature the umbonal region is quite flat. The surface striæ distinctly alternate in size, the cardinal area is fully denticulated and closed except for a very narrow deltidium. Sometimes the shell is extended on the hinge. The small New York expression of *D. cayuta* has the same characters as those here mentioned but has not been specially studied. It is seldom if ever as abundant as var. *graciliora* in Maryland.

Length 9 mm.; width 13 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Section on road from Oakland to Altamont; Redhouse abundant; Deer Park; National Road west of Frostburg.

Collection.—Maryland Geological Survey.

DOUVILLINA ARCUATA (Hall)

Plate XLIX, Figs. 14-17

Strophodonta arcuata Hall, 1858, Geol. of Iowa, p. 492, pl. iii, figs. 1, 2.

Description.—This little species, first described from the upper Devonian beds of Lime Creek and Hackberry Grove, Iowa, was identified some years ago in the Chemung beds lying near the base of the formation, in Ontario County, New York, where it is associated with a number of other western species.[1] Elsewhere in the Chemung of New York the species has not been recorded.

Douvillina arcuata is of the same type of generic structure as its associate *D. cayuta* and the Hamilton species *D. inequistriata* Conrad, characterized by its subcircular and elevated ventral muscular platform and the divergent fulcra between the anterior and posterior pairs of adductor scars in the dorsal valve. In contour the shell has a flattened umbonal area and a rather abrupt deflection and long slope to the anterior margin. Indeed in these respects the shell is rather more convex than specimens from the Iowa localities. The surface bears quite regularly fasciculated striæ. The shell is always small and its dimensions are quite in consonance with those of the species as elsewhere found.

Length 15 mm.; width 17 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Garrett County, between Oakland and Deer Park and 2 miles south of Oakland and in Green Glade Run; near Redhouse; National Road, 6½ miles west of Frostburg.

Collection.—Maryland Geological Survey.

Genus STROPHONELLA Hall

STROPHONELLA cf. REVERSA (Hall)

Plate XLIX, Fig. 18

Strophodonta reversa Hall, 1858, Geology of Iowa, vol. i, pt. ii, p. 494, pl. iii, fig. 4.

Strophonella reversa Hall and Clarke, 1892, Paleontology of New York, vol. viii, pt. i, pl. xii, figs. 16-20.

[1] Clarke, Bull. U. S. Geol. Survey, No. 16, 1885.

Strophonella reversa Grabau and Shimer, 1909, N. Amer. Index Fos., vol. 1, p. 222, fig. 270.

Description.—Strophonella is a stropheodontid in which the relative convexity of the valves is normal in early growth but subsequently the ventral valve becomes concave and the dorsal convex. *Strophonella reversa* is distinguished by its considerable size, coarse radial plications in the umbonal region, almost or fully obliterated deltidium, denticulate hinge, strongly elevated ventral muscle scars, thickened and sinused pallial region.

Whether or not the shell here under observation is a true *Strophonella* can not be fairly determined from the single interior of the dorsal valve in the collection. Nevertheless it is directly comparable with the species above cited as it shows a surface curvature normal to the younger conditions of that species where the primitive concavity of the dorsal surface is gradually changing to convexity about the margins. The internal markings are those of the species and in addition thereto the shell bears the median often irregular depression of the surface which is always noteworthy in *S. reversa.*

Length 17 mm.; width 25 mm.

The single specimen recorded is from the region a few miles south of Oakland. *Strophonella reversa* is common in the upper Devonian of Rockford, Iowa, of rare occurrence in the Chemung of New York.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. South of Oakland.

Collection.—Maryland Geological Survey.

STROPHONELLA sp.

Description.—An individual of this genus, which is too poor for specific identification, has been observed at the locality given.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road west of Frostburg.

Collection.—Maryland Geological Survey.

Genus SCHUCHERTELLA Girty

SCHUCHERTELLA CHEMUNGENSIS (Conrad)

Plate XLIX, Figs. 19-22; Plate L, Figs. 1-3

Streptorhynchus chemungensis Hall, 1867, Paleontology of New York, vol. iv, p. 67, pls. iv, ix, x.

Orthothetes chemungensis Hall and Clarke, 1892, Ibid., vol. viii, pt. i, pls. x, xi.

Schuchertella chemungensis Grabau and Shimer, 1909, N. Amer. Index Fos., vol. i, p. 230, fig. 281.

Description.—This is a shell attaining considerable size, often with the umbonal region more or less distorted from irregular growth, due in part at least to early cementation to foreign objects by the beak of the ventral valve. The shell, however, may be entirely free from evidence of such distortion and in the regularity of its form indicate undisturbed growth. The beak of the ventral valve is generally elevated with a correspondingly high cardinal area on which the deltidium is prominent. The ventral valve slopes anteriorly with normally convex but sometimes irregularly concave surface. The dorsal valve is gently convex or flat, also frequently showing irregularities of growth. On the interior of this valve is an erect lamellar cardinal process divided medially, and the four adductor scars are situated about or posterior to the middle of the shell. The exterior of the valves bears more or less regular and coarse subequal plications with occasional concentric interruptions to growth.

Length 25 mm.; width 35 mm.

Abundant at certain outcrops of the New York Chemung beds.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road, 6 miles west of Frostburg; Oakland-Redhouse Road; Oakland-Altamont Road; Trout Creek section, near Deer Park Station; Green Glade Run; Cherry Creek; Allegany Grove, 1633, 1750, 2000, 2076, 2340; Ellerslie, Pa., 1310 abundant, 1470 abundant, 1519; National Road, on Polish Mountain, 2706 abundant; Town Creek, 3593, 3942, 3982, 4480, 4769; 2 miles west of Pawpaw, West Virginia, 3540 common, 4570 ?; Fifteenmile Creek, 1 mile above mouth, 2286. PARKHEAD MEMBER. Allegany Grove, 850 ?.

Collection.—Maryland Geological Survey.

SCHUCHERTELLA ELLIPTICA n. sp.

Plate L, Fig. 4

Description.—Shell large, subelliptical. Ventral valve low convex, greatest convexity slightly posterior to middle; cardinal angles rounded. Dorsal valve not observed. Hinge-line straight, area triangular. Surface with numerous rounded striæ which are intersected by faint concentric striæ. Interior of ventral valve has two deep, divergent, flabelliform muscular scars and shows faint radiating striæ which are especially well preserved toward margins.

Length 30 mm.; width 48 mm.

This species differs from *S. chemungensis* in its rounded cardinal angles and unusually large flabelliform muscular scars. It is perhaps a very variant form of that species.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 4631.

Collection.—Maryland Geological Survey.

SCHUCHERTELLA ? PONDEROSA n. sp.

Plate L, Fig. 5

Description.—Shell large, semiovate, transverse, length about seven-eighths of width. Ventral valve convex, point of greatest convexity near umbo, anterior margin rounded, center depressed to form a broad, shallow, scarcely defined sinus. Umbo elevated, projecting beyond hinge-line. Shell thick. Dorsal valve unknown. Area triangular, inclined towards front, about 7 mm. high. Surface not known. Cast of interior of ventral valve shows large flabelliform scars for attachment of the diductor muscles, separated by small elliptical scars for attachment of adductor muscles. Diductors limited by a low, broad elevation, seen as a semicircular depression in cast. Surface of cast with irregular elevations due probably to imperfections in shell.

The cast of the interior of a single ventral valve distorted by pressure has been observed. Its features indicate that it is probably a Schuchertella although its generic relations are insecure.

Length 37 mm.; width 55 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Millstone, 2444.

Collection.—Maryland Geological Survey.

Family PRODUCTIDAE

Genus CHONETES Fischer

CHONETES LEPIDIFORMIS n. sp.

Plate L, Figs. 6-10

Description.—*Chonetes lepidus* Hall, a common species occurring in the Hamilton fauna of New York, and extending into the fauna of the Ithaca and Chemung beds, is a shell characterized by its small size and 2 strong divergent median plications, between which lie 3 or 4 small plications. On the lateral slopes are 10-13 sharp angular plications which bifurcate freely (see Paleontology of New York, vol. iv, p. 132, pl. xxi, fig. 5, pl. xxii, figs. 12, 13). This character of surface is presented by a Maryland shell which deviates from *C. lepidus* in its larger size, proportions and the degree of its plication. At times approaching that species very closely, these shells show a variability in form and surface which requires for them a distinct designation though they show in their own structure their ancestry as is suggested in the specific name.

Shells small or of medium size for this genus; generally subsemicircular or slightly elongate axially, often however quite transverse. Surface depressed convex. Two strong striæ or plications start at the beak, soon taking on the character of low folds dividing into plications but leaving a marked axial depression between them to the pallial margin. In some cases 2 plications of conspicuous size are continuous from beak to margin and in this respect the resemblance to *C. lepidus* is pronounced. The axial plications are somewhat smaller than the rest and each of the lateral slopes may bear 12-15 plications which bifurcate toward the margin. The cardinal margin of the ventral valve bears spines of considerable length the outermost being directed outward with a slight curve. The shells of this species attain a length of 10-12 mm. and usually have about the same width on the hinge.

The species is not common and has been found freely only at one locality, on the National Road, just east of Millstone, where it occurs in a yellow argillaceous sandy shale. It is also reported from the soft olive shales of the lower beds of the series at the foot and on the slope of Polish Mountain, on the National Road.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. National Road, east of Millstone; Polish Mountain, east of Gilpin.

Collection.—Maryland Geological Survey.

CHONETES OAKLANDENSIS n. sp.

Plate L, Figs. 14-18

Description.—Shell transverse, semielliptical, hinge-line longer than width of shell, cardinal angles acute. Ventral valve convex, regularly rounded from umbo to anterior margin, greatest convexity near middle of valve; concave toward cardinal angles. Umbo narrow, elevated. Area narrow, not distinctly shown in individuals observed. Dorsal valve concave, the concavity less than convexity of pedicle valve.

Surface bearing 50 to 60 fine, rounded, straight striæ which increase by intercalation and occasional bifurcation. Striæ obsolete near cardinal angles. About 4 striæ occupy the space of 1 mm. near the anterior margin of shell. The striæ are crossed by very fine concentric striæ which are visible only in very perfectly preserved specimens. A few coarser concentric growth lines occur near anterior margin.

The cardinal margin bears 3-4 short spines on each side of umbo which are directly obliquely outwards. Interior muscular markings not observed.

Length 6 mm.; width 9 mm.

This species resembles *C. scitulus* in its outline. The striæ, however, are quite different. In *C. scitulus* many of the intercalated striæ are very short, being present only near the margin. In this species the striæ are much finer while the intercalated striæ are much longer. It closely approaches *C. lineata* of the Hamilton of New York, but differs in being less convex, valves not distinctly flattened in the middle, spines more numerous. It belongs, however, to the group of *C. lineata* and *C. yandellana.*

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road, 6 miles west of Frostburg; Oakland-Altamont Road; Redhouse Road, west of Green Glade Run on road from Deer Park; Allegany Grove, 1750, 2076 abundant; Cherry Creek; Bear Pen Run, near junction with Savage River.

Collection.—Maryland Geological Survey.

CHONETES SCITULUS Hall[1]

Plate L, Figs. 11-13

Description.—This species is common in the Chemung, less frequent in the Parkhead. The Maryland individuals agree well with the typical forms from New York.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Allegany Grove, 2076; Town Creek, 2023, 2228; Fifteenmile Creek, 1 mile above Little Orleans, 2215; Hancock, 2219, 2223; Millstone, 2225, 2322 abundant. PARKHEAD MEMBER. Rocky Run: Road 1 mile north of Rocky Run, abundant; Williams Road, east of Cumberland, 1466 common; Williams Road on Polish Mountain 1289, 1371, 1422.

Collection.—Maryland Geological Survey.

CHONETES ROWEI n. sp.

Plate L, Fig. 19

Description.—In association with *C. lepidiformis* at Millstone, occurs a specimen here figured, a very transverse ventral valve bearing about 40 subequal, rounded and very irregularly bifurcating plications, the surfaces of which are minutely but distinctly spinous. This last is a most notable feature for a shell of the genus *Chonetes* and has not been recorded before. This single specimen is defective along the beak and it cannot be clearly determined whether cardinal spines are or were present, but the expression of the shell favors the view that these chonetid characters existed. We are not justified in regarding these spinules related to or structurally connected with the papillose internal surface and exposed by exfolia-

[1] For synonymy and description see p. 150.

tion. The development of these characters is insufficient to bring the shell into close association with the productoid genera, *Productella* and *Productus*. It is much to be regretted that other representatives of this interesting shell have not been observed.

Length 6 mm.; width 10 mm.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Millstone.

Collection.—Maryland Geological Survey.

Genus PRODUCTELLA Hall

PRODUCTELLA LACHRYMOSA (Conrad)

Plate L, Figs. 20-22; Plate LI, Figs. 1-3

Strophomena lachrymosa **Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 256, pl. xi, fig. 9.**

Productella lachrymosa **Hall, 1867, Paleontology of New York, vol. iv, p. 172, pl. xxv, figs. 23-28.**

Description.—Shells subhemispheric, subelliptical in marginal outline; hinge-line equalling or shorter than the width of the valves. Ventral valve convex or ventricose, often medially depressed. Surface closely spinous, the spine bases being elongate and arranged with some regularity in concentric rows, depressed lateral slopes with more erect spines. Dorsal valve concave. Sharp internal casts show admirably the narrow cardinal area in both ventral and dorsal valves, and the matrix of the specimens contains spines a half-inch in length. The interior of dorsal valve shows but faint trace of median septum and the cardinal process is erect, thin and bifurcate at its crest. The expression of some of the shells which are medially depressed and somewhat extended transversely is that of the New York variety *lima* Hall, but it is impracticable here to differentiate these from the associated shells.

Length 22 mm.; width 27 mm.

This species is subject to wide variation. It differs from *P. speciosa* in its large inflated umbo and in possessing fewer spines, which are attached by elongated bases. This form is abundant in the Parkhead, and somewhat less abundant in the Chemung of Maryland.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Oakland-Redhouse Road; Trout Run; National Road, on Polish Mountain near

top of mountain, abundant; Williams Road, on Polish Mountain, 2042. PARKHEAD MEMBER. Allegany Grove, 850 ? Williams Road, on Polish Mountain, 1660 abundant; Town Creek, 1863; 2 miles west of Pawpaw, 1794.

Collection.—Maryland Geological Survey.

PRODUCTELLA LACHRYMOSA VAR. MARYLANDICA n. var.

Plate LI, Figs. 4-9

Description.—Quite as abundant locally as the preceding species is a much and persistently smaller shell, with more sparsely echinate surface. There is no material difference between these and *P. lachrymosa* in the proportions or internal structure of the valves, but the exterior distinction is marked, the surface being sometimes almost devoid of spines and apparently irregularly tubercled, but generally the elongate spine-bases are well apart over the pallial region; on the cardinal slopes they become erect and are somewhat more abundant. This shell is readily distinguished by these features and it is clearly allied to *P. lachrymosa*.

Individuals occurring in the section on Williams Road on Polish Mountain are larger than those figured and the umbo is more inflated, in which respect they approach the normal form more closely.

Length 13 mm.; width 16 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Williams Road, Polish Mountain, 1967, 2024 abundant; National Road, Polish Mountain, abundant in b'ocky arenaceous shales; along Sideling Hill Creek on Pennsylvania-Maryland state line, on top of hill.

Collection.—Maryland Geological Survey.

PRODUCTELLA LACHRYMOSA var.

Plate LI, Figs. 10-12

Description.—This variety differs from the typical form of *P. lachrymosa* in its closer and more slender spines in which respect it approaches *P. speciosa.* The umbo is larger, however, than in that species. It suggests *P. hirsuta* but does not show the concentric striæ of that species.

The specimens figured resemble the latter species in their irregular shape, though this is not a constant feature of this variety.

Length 22 mm.; width 25 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road 7 miles west of Frostburg; Oakland-Altamont Road; Oakland-Redhouse Road; Trout Run; near Deer Park; National Road near top of Polish Mountain; Ellerslie, Pennsylvania, 1316, 1474.

Collection.—Maryland Geological Survey.

PRODUCTELLA SPECIOSA Hall

Plate LI, Figs. 13-15

Productus speciosus **Hall, 1857, 10th Rept. N. Y. State Cab. Nat. Hist., p. 176**
Productella speciosa **Hall, 1867. Pal. of N. Y., vol. iv, p. 175, pl. xxv, figs. 1-11.**
Productella speciosa **Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 242, fig. 294.**

Description.—Shell broadly ovate, subhemispheric; hinge-line shorter than the greatest width of the shell. Ventral valve ventricose; dorsal valve concave. Surface of ventral valve with fine concentric striæ and a few short wrinkles on the umbonal slopes. Both valves abundantly spinous, much more so than in *P. lachrymosa.*

Length 20 mm.; width 27 mm.

This species differs from *P. lachrymosa* in its more closely set spinules and smaller umbo. In some of the Maryland individuals the umbo is larger than in the specimens figured by Hall. It is, however, smaller and less inflated than in *P. lachrymosa.* This is one of the most abundant and characteristic species of the Ithaca fauna both of Maryland and of New York .

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Two miles west of Pawpaw, West Virginia, 1340, 1388 abundant; Little Orleans, 1446 abundant; Fifteenmile Creek, 1 mile above Little Orleans, 1446; Woodmont, 710, 776, 1020, 1032, 1067; National Road, west of Tonoloway Ridge, 980, 1029 abundant, 1038 abundant; Berkeley Springs, W. Va., 775, 1058, 1064, 1074, 1080, 1163, 1371: National Road, east of Hancock, 690, 994, 1149 1231; Hancock-Harrison-

ville Road 882, 944; Thompson Township, Fulton County, Pennsylvania, 1300; Yellow Springs Run, 1124, 1139, 1222; Millstone, 795, 1122, 1149.

Collection.—Maryland Geological Survey.

PRODUCTELLA HYSTRICULA Hall

Plate LI, Figs. 16-19

Productella hystricula **Hall, 1867, Paleontology of New York, vol. iv, p. 178, pl. xxvi, figs. 1-8.**

Description.—Shell small, convexo-concave; hinge-line shorter than the width of the valves, surface puckered along the hinge toward the cardinal angles, wrinkles continued over the shell as fine concentric lines bearing numerous slender spines. Dorsal valve with pustulose concentric wrinkles.

Length 9 mm.; width 12 mm.

This is a very small species as preserved in the Maryland rocks and has not been found well enough retained to permit its illustration. It may, however, be recognized by its diminutive size and the abundance of hair-like spines on its surface.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. On the road over Trout Run, 2 miles south of Oakland.

Collection.—Maryland Geological Survey.

PRODUCTELLA NAVICELLIFORMIS n. sp.

Plate LI, Fig. 20

Description.—Shell small, subcircular, length and width subequal. Hinge-line straight, a little shorter than greatest width of shell. Ventral valve very gibbous, arcuate; umbo much incurved, projecting a little beyond hinge-line. Point of greatest convexity posterior to middle of shell, surface curving abruptly towards cardinal angles which are concave. Dorsal valve not observed.

Surface ornamented by closely set spinules, the bases of which are linear and form slender interrupted costæ. This species closely resembles *P. navicella* of the Onondaga and Hamilton but differs in being less elongate and having a less prominent umbo. It resembles *P. hystricula*

from which it differs in being less transverse, more gibbous with less conspicuous spinules, the bases of which form more distinctly elevated interrupted costæ. It differs from the other species of the fauna in its smaller size.

Length 10 mm.; width 11 mm.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Williams Road, east of Cumberland, 1466 common; roadside, 1 mile north of Rocky Run?

Collection.—Maryland Geological Survey.

Genus PRODUCTUS Sowerby

Subgenus MARGINIFERA Waagen

PRODUCTUS (MARGINIFERA) HALLANUS Walcott

Plate LI, Figs. 21-23

Productus dissimilis Hall, 1858, Geology of Iowa, vol. i, pt. ii, p. 497, pl. iii, fig. 7.

Productus (Productella) hallanus Walcott, 1885, Paleont. of the Eureka Dist., p. 130, pl. xiii, fig. 17.

Productus (Marginifera?) dissimilis Hall and Clarke, 1892, Paleont. of New York, vol. viii, pt. i, pl. xviia, figs. 11, 12.

Description.—Shell subcircular, strongly convex; surface of ventral valve bearing distinct radial striæ interrupted by occasional growth lines, spines few, erect and irregularly scattered. Dorsal valve with no radial surface lines or spines but with sharply defined and regular concentric ridges. On the interior the umbo-lateral areas are flat and denticulated along ridges diverging obliquely from the beaks.

Length 12 mm.; width 14 mm.

This shell, first described from the upper Devonian of Rockford, Iowa, has been more recently identified in Nevada (Walcott, *loc. cit.*) and in the lower beds of the Chemung in western New York.[1] In the material described from Maryland the shell has seldom been observed, but its occurrence is undoubted as the characteristics of the species are sharply defined. The exterior of a dorsal valve figured bears the sharp con-

[1] Clarke, Bull., U. S. Geol. Survey, No. 16.

centric shell laminæ and shows the flattened cardinal slopes, two features which serve to distinguish the species. The ventral valve bears the rounded radial striæ, sparsely spinous. The reference of this species to the subgenus *Marginifera* was based upon the development of granulose divergent ridges on the interior of both valves making a sharp division between the cardinal shoulders and the general interior cavity of the shell; an inceptive condition in relation to the fully developed differentials of the Carboniferous and Permian *Marginifera*.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Oakland-Altamont Road; Gordon's farm, 1 mile northeast Mountain Lake Park; road over Trout Run, 2 miles south of Oakland.

Collection.—Maryland Geological Survey.

Family ORTHIDAE

Genus DALMANELLA Hall and Clarke

DALMANELLA TIOGA (Hall)

Plate LII, Figs. 1-4

Orthis interlineata **Hall (non Sowerby), 1843, Geol. N. Y., Rept. 4th Dist., p. 267, figs. 3, 4.**

Orthis tioga **Hall, 1867, Pal. of N. Y., vol. iv, p. 59, pl. viii, figs. 20-29.**

Schizophoria tioga **Hall and Clarke, 1892, Pal. of N. Y., vol. viii, pt. i, pp. 212, 226, pl. vi, figs. 17, 18.**

Dalmanella tioga **Williams, 1908, Proc. U. S. Nat. Mus., vol. xxxiv, p. 55, pl. iii, figs. 1-7, 9, 10, 12.**

Schizophoria tioga **Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 268, fig. 321.**

Description.—" Shell transverse, broadly elliptical, about two-thirds as long as wide; length of hinge-line a little greater than half the width of the shell; the extremities rounded into a general curved outline. Dorsal valve convex, the greatest elevation near or above the middle on each side of a well-marked mesial sinus; sometimes a little flattened at the sides, and regularly curving to the front. Ventral valve very gently convex, with sometimes a slight mesial elevation; area of medium width, with the beak slightly incurved; foramen wide.

"Surface striated; striæ angular, often fasciculate, curving upwards on the hinge-line.

"..., the striæ are angular, and every second one in the upper part of the shell, and every third or fourth one in the lower part of the shell, are stronger and more prominent; concentric striæ fine and closely arranged. In the casts, the character of the striæ is tolerably well preserved in the fasciculate arrangement, and in the curving upward at the sides and on the hinge-line; while on the margin, they are much more strongly impressed than on the middle of the cast. When the cast is preserved in fine shale or shaly sandstone, the surface is minutely punctate; and the shell when preserved has the same character.

"The muscular impression in the dorsal valve is usually but faintly defined in the casts, which preserve the impression of a strong cardinal process bifid at the extremity. The socket plates are strong and widely diverging, and the area is extremely narrow. In the cast of the ventral valve the muscular impression is subpentagonal, deeply bilobed below; the bases of the divisions rounded, and the sides slightly indented. The area is narrow, incurved in the middle, and extends about two-thirds the width of the shell." Hall, 1867.

A number of individuals observed have greatest width posterior to middle of valve showing a modification towards the form *D. carinata*.

Length 20 mm.; width 27 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Ellerslie, Pennsylvania, 1316 abundant, 1474 abundant, 1508; west of McCool about 1300 abundant.

Collection.—Maryland Geological Survey.

DALMANELLA CARINATA (Hall)

Plate LII, Fig. 5

Orthis carinata Hall, 1843, Geol. N. Y. Rept. 4th Dist., p. 267, fig. 1.
Orthis carinata Hall, 1867, Pal. of N. Y., vol. iv, p. 58, pl. viii, figs. 30-32.
Schizophoria carinata Hall and Clarke, 1892, Pal. of N. Y., vol. viii, pt. i, pp. 213, 226, pl. vi, fig. 22.
Dalmanella carinata Williams, 1908, Proc. U. S. Nat. Mus., vol. xxxiv, p. 57, pl. iv, figs. 1, 2, 4, 6.

Description.—" Shell transverse, often much wider than long, subplano-convex; hinge-line nearly or quite equal to three-fourths the greatest width of the shell, and about equal to its length; cardinal extremities rounded. The dorsal valve is very convex or gibbous, with a deep rounded sinus in the median line, abruptly curving towards the cardinal line and somewhat more gently to the front, depressed and scarcely flattened at the cardinal extremities. Ventral valve nearly flat, or rising from the base to the umbo with little convexity; median line carinate, with a strong and defined angular ridge, front abruptly sinuate; area comparatively narrow, a little curved near the beak; foramen wide.

" Surface marked by fine radiating striæ, which increase by bifurcation and interstitial additions, and are strongly curved upwards to the hinge-line; testure punctate. The specimens are mainly casts, and the lines of growth are obscure.

" The cast of the dorsal valve shows a wide subquadrate muscular impression, divided by a rounded median ridge, and transversely by a low ridge on either side, after the manner of *O. elegantula* and others of that type. The socket plates are strong and very divergent, and the cardinal process is apparently triplicate; the area is narrow and flat.

" The cast of the ventral valve is nearly flat on the sides, with a defined angular carina along the median line. The muscular impression is subquadrate, deeply bilobed below, and slightly lobed at the sides. The dental lamellæ are strong and triangular.

" In specimens which have suffered compression, the length is about three-fourths the width; but in some individuals the width is nearly double the length." Hall, 1867.

This species is characterized by a deep sulcus on dorsal valve, very elevated angular fold on ventral valve, and greatest width posterior to middle of valve. A single valve has been observed.

Length 18 mm.; width 28 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Near Ellerslie, Pennsylvania.

Collection.—Maryland Geological Survey.

DALMANELLA sp.

Plate LII, Fig. 6

Description.—A small well-defined ventral valve shows the occasional presence of a species of *Dalmanella* not unlike *D. leonensis* Hall of the New York Chemung fauna but perhaps more closely comparable to *D. infera* Calvin from the Independence shales of Iowa. Nothing is known of the species except the exterior of the ventral valve which is subcircular and transverse, gently ridged axially and with sharply defined bifurcating striæ.

Length 7 mm.; width 9 mm.

Occurrence.—JENNINGS FORMATION. Polish Mountain section east of Gilpin.

Collection.—Maryland Geological Survey.

Genus RHIPIDOMELLA Œhlert

RHIPIDOMELLA VANUXEMI (Hall)[1]

Plate LII, Figs. 7-13

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Two and three-quarters miles southwest of Round, West Virginia, in upper *Tropidoleptus zone.* PARKHEAD MEMBER. Williams Road, east of Cumberland, 1391; $2\frac{1}{4}$ miles southwest of Cumberland; Rocky Run; Williams Road on Polish Mountain, 1289, 1371, 1422.

Collection.—Maryland Geological Survey.

Genus SCHIZOPHORIA King

SCHIZOPHORIA STRIATULA (Schlotheim)

Plate LII, Figs. 14-18; Plate LIII, Figs. 1, 10

Anomia Terebratulites striatulus **Schlotheim, 1813. Min. Taschenbuch VIII, pl. i, fig. 6.**
Orthis impressa **Hall, 1843, Geol. N. Y. Rept. 4th Dist., p. 267, fig. 2.**
Orthis impressa **Hall, 1867, Pal. of N. Y., vol. iv, p. 60, pl. viii, figs. 11-19.**
Schizophoria striatula **Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 268, fig. 321.**
Schizophoria striatula **Cleland, 1911, Bull. xxi, Geol. Surv. Wis., p. 93, pl. xix, figs. 1-6.**

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[1] For synonymy and description see page 165.

Description.—Shell with convex dorsal and medially concave ventral valves. The latter has a straight hinge-line and narrow cardinal area, narrow acute beak, and broad plane to slightly convex lateral slopes, while the former or dorsal valve is rotund with umbo full and rounded, and with broad median elevation. In general outline the valves are transversely elliptical, much wider than long. Exterior covered with uniformly fine striæ crossed by occasional rings of growth. On the interior the ventral valve has a short obcordate muscular scar, while in the dorsal valve the scar is quadripartite, also short. Frequently vascular sinuses cover the pallial region.

Schizophoria striatula is a member of a chain of closely allied shells occurring at various horizons in the Devonian, beginning with *S. propinqua* Hall of the Onondaga limestone, followed by *S. tulliensis* Vanuxem of the Tully limestone; then by *S. striatula* Schloth. of the Ithaca and Chemung. In the upper Devonian of Iowa the same type is represented by *S. iowensis* Hall which approaches closely to *S. tulliensis.*

Schizophoria striatula is a large and robust species attaining uniformly greater size than any of the rest. Its surface markings are also coarser than in its allies; *S. tulliensis* and its western ally *S. iowensis* are of smaller build with very gibbous dorsal valve, narrow median depression on ventral valve and more sharply sinuous anterior margin; *S. propinqua* is a still smaller less convex and somewhat more graceful shell.

The genus *Schizophora* differs from the genus *Dalmanella* which has fasciculate striæ, carinate ventral valve and different muscular scars. It differs from *Rhipidomella* which has large flabelliform muscular scars in the ventral valve. It differs from both these genera in having convex dorsal valve and sinus in ventral valve. This is one of the most conspicuous species of the Ithaca fauna, in which it often attains very large size. It occurs more rarely in the Parkhead and Chemung. The individuals from higher horizons are frequently smaller than those occurring in the Ithaca fauna.

Length large individual 30 mm.; width 40 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Ellerslie, Pennsylvania, 1474 common; Williams Road on Polish Mountain, 1967;

Town Creek, 3942 common. PARKHEAD MEMBER. Rocky Run; Williams Road on Polish Mountain, 1660. WOODMONT MEMBER, ITHACA FAUNA. Two miles west of Pawpaw, West Virginia, 1340 abundant, 1388 abundant; Little Orleans, 1446; Woodmont, 1032, 1067 common; Hancock, 690 abundant; Hancock-Harrisonville Road, 726 abundant, 880, 944; Millstone, 1057; Berkeley Springs, West Virginia, 786 common, 1058, 1080, 1371; Yellow Springs, West Virginia, 734 abundant.

Collection.—Maryland Geological Survey.

SCHIZOPHORIA STRIATULA VAR. MARYLANDICA n. var.

Plate LIII, Figs. 2-9

Description.—This is a persistently small shell, none of the specimens we have observed attaining the dimensions even of *S. propinqua.* The largest of these are only about 20 mm. wide while the average specimen in places where they most abound is considerably smaller.

Ventral valve convex in the umbonal region with erect but not conspicuous beak. A median sinus begins on the umbo, widens rapidly, on the margin covering fully one-half the width of the valve, and becomes deeply and distinctly impressed. Hinge-line shorter than one-half the width of the valve. The dorsal valve is full and gibbous at the umbo which projects beyond the short hinge-line with decided concave slopes to the lateral margins. Corresponding to the median depression of the opposite valve is a broad, low, very obscure convexity, over which the sparse concentric growth lines when present make a retral curve, and which is flattened or even depressed and grooved on its summit. This median depression of the valve renders it often of an aspect so similar to that of the ventral valve that it is sometimes difficult to distinguish one from the other. The surface striæ vary irregularly in size, are rounded and simple, increasing by intercalation.

This variety is very well defined and will be recognized by its uniformly and contrasting small size, broad ventral sinus, obscure and depressed dorsal fold. It is distinguished from the various Devonian representatives of the genus already mentioned by a greater difference than is recognizable between any two of these, but as it occurs in the same

fauna with *Schizophoria striatula* it seems wiser at the present to distinguish it by a varietal term only.

Length 13 mm.; width 18 mm.

At some localities a few shells have been seen which pass the limits of size of var. *marylandica* and lack the marked median depression in both its valves. These are probably young shells of *S. striatula.*

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road west of Frostburg; Oakland-Altamont Road; Deer Park Station and between there and Oakland; south of Oakland at crossing of Cherry Creek; ¾ mile west of junction of Oakland-Deer Park Road with Deer Park-Mountain Lake Park Road, abundant; Allegany Grove, 2020, 2076; Town Creek, 4769.

Collection.—Maryland Geological Survey.

Order TELOTREMATA

Superfamily RHYNCHONELLACEA

Family RHYNCHONELLIDAE

Genus CAMAROTOECHIA Hall and Clarke

CAMAROTŒCHIA CONGREGATA VAR. PARKHEADENSIS n. var.

Plate LIII, Figs. 11-16

Description.—Shell ovate, width usually a little greater than length, front rounded or slightly truncate; apex pointed. Ventral valve convex at sides, depressed in middle; mesial sinus beginning near apex, becoming deep in front where in some cases it may form a lingua-form extension; beak closely incurved over that of dorsal valve in older shells, slightly curved in younger shells. Dorsal valve convex to gibbous, mesial fold beginning near apex and becoming prominent towards front. Surface marked by angular plications of which 3, less frequently 4 and occasionally 5, occupy sinus, and 4 to 6 occur on each side of fold.

The individuals here described differ from the typical form in frequently having a deeper sinus bearing 3-5 plications, and in being less rotund and more transverse. They resemble *C. contrata* but differ in

being less transverse, sinus less sharply depressed, umbo of ventral valve less gibbous, plications less angular, 3-5 plications on sinus, septum and dental lamellæ more prominent. While referable to *C. congregata* they show clear affinities with *C. contracta*. These two species are so closely connected by transitional forms that it appears not improbable that *C. congregata* of the Hamilton may have given rise to *C. contracta* of the upper part of the Chemung rendering the discrimination of the two species insecure at times. This is especially true of individuals occurring in the lower part of the Chemung, some of which might be referred with almost equal propriety to either species. Typical individuals of *C. contracta* appear only in the upper part of the Chemung of Maryland so far as observed.

This variety is one of the most characteristic and abundant forms of the Parkhead fauna, being found in certain layers in such profusion as to form a veritable coquina, and is one of the most valuable horizon markers of the Parkhead, with which it is coextensive. It occurs chiefly in the massive sandstones and conglomerates of that member.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Allegany Grove, 800, 850; Williams Road, on Polish Mountain, 1289, 1362, 1371, 1524, 1660 abundant; National Road, on Polish Mountain, 1196, 1625; section 2 miles north of mouth of Town Creek, 1282 abundant, 1312 abundant, 1642 common, 1687 abundant, 1716, 1723 abundant, 1917; Town Creek, 1605 abundant, 1679 abundant, 1863 abundant; 2 miles west of Pawpaw, West Virginia, 1493 abundant, 1584 abundant, 1712 abundant, 1894; Little Orleans, 730 abundant; Fifteenmile Creek, 1 mile above Little Orleans, 1713, 1746 abundant, 1766 abundant, 1773 abundant; Tonoloway, 1285 abundant; Hancock, 1600 abundant; Millstone, 1600 abundant; Berkeley Springs, West Virginia, 1560 abundant; Yellow Springs, West Virginia, 1600 abundant; 2½ miles north of mouth of Sideling Hill Creek, abundant; Woodmont, 1285; National Road, west of Tonoloway Ridge, abundant. An unusually large form of this variety occurs in the Parkhead in the section on Williams Road, 4 miles east of Cumberland, 1393; road 1 mile north of Rocky Run and 1¾ miles east of the crest of Knobly Mountains. A variety of this form with sinus

deeper than usual suggestive of *C. contracta,* occurs associated with the preceding. It differs from *C. contracta* in the frequent presence of 4 or 5 plications in sinus while length and width are subequal in many individuals. Many specimens are quite convex.

Collection.—Maryland Geological Survey.

CAMAROTŒCHIA CONTRACTA (Hall)

Plate LIII, Figs. 18-21

Atrypa contracta **Hall, 1843, Geol. of N. Y.; Rept. on the 4th Dist., pl. lxvi, fig. 3.**

Rhynchonella (Stenocisma) contracta **Hall, 1867, Pal. of N. Y., vol. iv, p. 351, pl. lv, figs. 26-39.**

Camarotœchia contracta **Hall and Clarke, 1894, Pal. of N. Y., vol viii, pt. ii, pl. lvii, figs. 28-32.**

Camarotœchia contracta **Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 288, figs. 352*d-g*.**

Description.—*Camarotœchia contracta* is a transversely oval shell with fold and sinus clearly developed from the beak outward and becoming very conspicuous on the margin. The valves are relatively shallow and the plications coarse. Of the latter the fold and sinus bear three or four and each lateral slope 7-8. The boundary plications on fold and sinus have specially broad inner slopes.

Concerning the limits of this species see remarks under *C. congregata* var. *parkheadensis.* Typical *C. contracta* is characterized by its transverse form, flat valves, deep sinus and angular plications, 3 of which occupy the sinus. It occurs chiefly in the upper strata of the Chemung.

Length 15 mm.; width 18 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Allegany Grove, 2960, 2980; National Road, on Polish Mountain, 2929; Millstone, 3116 (small var.); 5 miles west of Piney Grove in olive shales. Specimens from Millstone at 3116 are much smaller than the other forms termed *C. contracta.* They also differ from the typical form in that the sinus does not begin so near the umbo and is not so pronounced, the umbo of the ventral valves is unusually convex, the dental lamellæ all longer. The

reference of the latter individuals to *C. contracta* is not assured as they approach some varieties of *C. congregata* var. *parkheadensis*.

Collection.—Maryland Geological Survey.

CAMAROTŒCHIA HORSFORDI (Hall)

Plate LIII, Figs. 22-25

Rhynchonella horsfordi **Hall, 1860. 13th Rept. N. Y. State Cab. Nat. Hist., p. 87.**

Rhynchonella (Stenochisma) horsfordi **Hall, 1867, Pal. of N. Y., vol. iv, p. 339, pl. liv, figs. 24-32.**

Camarotœchia horsfordi **Hall and Clarke, 1893, Pal. of N. Y., vol. viii, pt. ii, p. 192, pl. lvii, figs. 7-9.**

Camarotœchia horsfordi **Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 287, figs. 354*a*, *b*.**

Description.—" Shell, in full-grown specimens, transversely subelliptical; rostral portion sometimes a little extended; front nearly straight or broadly rounded; length and width about as five to six or seven. Young shells ovoid subtrigonal.

" Ventral valve moderately convex, flattened and incurved in front; a slightly depressed sinus, appearing about the middle of the length, which is flat in the bottom and curving abruptly upwards in front; beak moderately extended, abruptly acute and usually but little incurved.

" Dorsal valve very gibbous in old shells, sloping abruptly to the beak; depressed-convex in young shells. Mesial elevation defined below the middle of the length.

" Surface marked by about fifteen or sixteen to twenty-four well-defined angular plications, of which four to six or seven mark the medial sinus and fold, which are deeply bifurcated in front. On the sides and towards the cardino-lateral margins of the shell the plications are less angular; concentrically marked by fine undulating striæ, which are seen towards the front, but rarely on other parts of the shell." Hall, 1867.

Length 15 mm.; width 20 mm.

Of rare occurrence in the Parkhead.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Two miles west of Pawpaw, West Virginia; Sideling Hill Creek $2\frac{1}{2}$ miles above mouth.

Collection.—Maryland Geological Survey.

CAMAROTŒCHIA ORBICULARIS (Hall)

Plate LIII, Figs. 26, 27

Rhynchonella orbicularis **Hall, 1860, 13th Rept. N. Y. State Cab. Nat. Hist., p. 88.**

Rhynchonella (Stenochisma) orbicularis **Hall, 1867, Pal. of N. Y., vol. iv, p. 353, pl. lv, figs. 40-46.**

Camarotœchia orbicularis **Hall and Clarke, 1893, Pal. of N. Y., vol. viii, pt. ii, p. 192, pl. lvii, figs. 46-48, 50.**

Description.—"Shell suborbicular, ventricose on the dorsal valve; width greater than the length.

"Ventral valve moderately convex, scarcely gibbous on the umbo; beak incurved; outline gently curving on the lateral and baso-lateral margins, and the center gently depressed in a broad and strongly defined median sinus.

"Dorsal valve gibbous in the middle, arcuate from beak to base; sides abruptly curving to the ventral valve; median fold beginning above the middle of the length, and becoming more prominent towards the front.

"Surface marked by about twenty-four or more subangular or rounded ribs, those of the central portion being strong and elevated, and those towards the cardinal slope gradually finer and less distinct. There are four or five plications in the mesial sinus, and from four to six on the mesial fold, which are moderately elevated and gently curving to the front. The plications on the sides are more or less abruptly curved to the margins of the shell. The shell when preserved, is marked by fine close concentric striæ." Hall, 1867.

Length rather small specimen 15 mm.; width 18 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Trout Run section near Mountain Lake Park; 2 miles west of Pawpaw, West Virginia, 3312.

Collection.—Maryland Geological Survey.

CAMAROTŒCHIA EXIMIA (Hall)

Plate LIV, Figs. 1-4

Atrypa eximia **Hall, 1843, Geol. N. Y. 4th Dist., tab. 66, fig. 4.**

Rhynchonella (Stenochisma) eximia **Hall, 1867, Pal. N. Y., vol. iv, p. 348, pl. lv, figs. 1-8.**

Camarotœchia eximia **Hall and Clarke, 1893, Pal. of N. Y., vol. viii, pt. ii, p. 192, pl. lvii, figs. 44-45.**

Description.—Shell triangular-ovate, length and width subequal, valves subequally convex. Angle over umbo acute. Ventral valve moderately convex at umbo; a wide undefined sinus arising near middle of valve and becoming slightly better defined near front. Dorsal valve about as convex as ventral valve; a fold beginning near middle of valve which is sometimes distinct, but is usually illy defined. Surface bearing from 14 to 28 plications of which 4, 5 or at times 6 are in sinus and a corresponding number on fold. A mesial septum is present in the ventral valve, extending to near middle of valve.

Length usually 7 to 12 mm.; width about the same.

The shells referred to *C. eximia* differ from the larger individuals figured by Hall in the Paleontology of New York, vol. iv, and resemble the younger specimens illustrated by him. They are characterized by possessing fine plications, finer than in the other species of the fauna, illy defined sinus and fold, and in being usually slightly convex. This species is frequent in the Parkhead and abundant in the upper part of the Chemung. Specimens occurring in the upper iron-rich strata are usually small and apparently depauperate.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Allegany Grove, 2020, 2960; Town Creek, 3870, 3937, 3942 common, 3963 abunddant, 3982, 4631, 4716; 2 miles west of Pawpaw, West Virginia, 3846, 4570, 4636, 4694 common. PARKHEAD MEMBER. Two and one-fourth miles southeast of Cumberland, on road 1 mile north of Rocky Run and 1¾ miles east of Knobly Mountain; Williams Road, on Polish Mountain, 1289, 1352, 1371; 2 miles north of mouth of Town Creek, 1312; Sideling Hill Creek 2½ miles above mouth; Woodmont, 1285; Hancock, 1600; Millstone, 1600. Individuals with unusually deep sinus occur abundantly in the Chemung at Town Creek 3963 and 2 miles west of Pawpaw, West Virginia, 3846.

Collection.—Maryland Geological Survey.

Genus LIORHYNCHUS Hall

LIORHYNCHUS MESACOSTALE Hall

Plate LIV, Figs. 5-8

Atrypa mesacostalis **Hall, 1843, Geol. of N. Y., Rept. on the 4th Dist., p. 64, figs. a, b.**

Leiorhynchus mesacostalis **Hall, 1867, Pal. of N. Y., vol. iv, p. 362, pl. lvii, figs. 18-25.**

Description.—Shell of rhynchonelloid aspect with but moderately convex valves and quite low median fold and sinus. Fold and sinus bear three or four rounded plications which do not reach the beak, while on the lateral slopes of the valves plications are obscure or altogether obsolete leaving the surface smooth. With good preservation the exterior shows fine concentric lines crossed on the lateral slopes by radial striæ. In the dorsal valve a low median septum reaches to about the middle of the shell and at the beak supports a small triangular spondylium. In the ventral valve the muscular scars are almost linear and situated posteriorly. This species is common in the Ithaca fauna and in the overlying Chemung beds of southern central New York.

Length 18 mm.; width 20 mm.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Allegany Grove, 850 abundant; 2¼ miles southeast of Cumberland, south of Potomac River; Williams Road, east of Cumberland, 1393 abundant.

Collection.—Maryland Geological Survey.

LIORHYNCHUS cf. MULTICOSTUM Hall

Plate LIV, Fig. 9

Leiorhynchus multicosta **Hall, 1860, 13th Ann. Rept. N. Y. State Cab. Nat. Hist., p. 85.**

Leiorhynchus multicosta **Hall, 1867, Pal. of N. Y., vol. iv, p. 358, pl. lvi, figs. 26-40.**

Description.—Shell ovate in outline; biconvex; ventral valve gibbous on the umbo, depressed medially to a broad sinus. Dorsal valve the more convex with a broad median fold. Surface marked by rounded or subangular plications of which usually 3 to 6 are in the sinus and on the fold and 5-8 on each lateral slope. Fine concentric lines cover these ribs.

On the interior the ventral valve shows a well-marked pedicle cavity and dental lamellæ and in both valves the muscle scars are all obscure.

Length 24 mm.; width 25 mm.

The single large ventral valve here figured pertains to an individual which in its plicated sides and multiplicate sinus comes within the limits of the characters assigned to this species. This specimen alone is, however, insufficient to finally determine this identity.

Liorhynchus multicostum is a common species in the Hamilton fauna of New York and passes into the Ithaca fauna above. There is no record of its higher range in that State.

Occurrence.—JENNINGS FORMATION, PARKHEAD ? MEMBER. The single specimen is from blocky argillaceous layers on the west side of Green Ridge 5 miles west of Piney Grove, Garrett County.

Collection.—Maryland Geological Survey.

LIORHYNCHUS GLOBULIFORME (Vanuxem)

Plate LIV, Figs. 10-16

Atrypa globuliformis **Vanuxem, 1842, Geology of N. Y., Rept. on the 3d Dist., p. 182, fig. 2.**

Leiorhynchus globuliformis **Hall, 1867, Pal. of N. Y., vol. iv, p. 364, pl. lvii, figs. 26-29.**

Leiorhynchus globuliformis **Hall and Clarke, 1894, Pal. of N. Y., vol. viii, pt. ii, pl. lix, figs. 23-27.**

Description.—Shell suborbicular, rotund. Ventral valve convex over the umbo, depressed anteriorly; dorsal valve ventricose. Median fold and sinus obscure. Three or four ribs are present on fold and sinus but the lateral slopes are smooth or but obscurely plicate. Usually in casts, of which dorsal valves are characterized by the elongate vaginate muscular scar divided by a narrow median septum.

This shell abounds in and is highly characteristic of the Ithaca fauna of central New York.

Length 15 to 20 mm.; width 20 mm.

This species is distinguished by its convexity and by its muscular markings. It is one of the most abundant and characteristic species of the Ithaca fauna.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Two miles west of Pawpaw, West Virginia, 1340, 1388; Roadside east of Little Orleans, 1446; Fifteenmile Creek, 1 mile above Little Orleans, 1446; Woodmont, 1024 abundant, 1032 common, 1067; National Road, west of Tonoloway Ridge, abundant; Hancock, 1274, 1149 to 1274 abundant; Millstone, 1057, 1122 abundant, 1148 abundant; Berkeley Springs, West Virginia, 712 common, 1058, 1080, 1163 common; Yellow Springs Road, West Virginia, 629 abundant, 665 abundant.

Collection.—Maryland Geological Survey.

Genus PUGNAX Hall and Clarke

PUGNAX PUGNUS VAR. ALTUS (Calvin)

Plate LIV, Figs. 17-22

Rhynchonella alta[1] Calvin, *circa* 1875, privately distributed paper with figures.

Rhynchonella pugnus var. *alta* Williams, 1890, Bull. Geol. Soc. Amer., vol. i, pl. xii, figs. 5-7.

Pugnax altus Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, p. 203, pl. lx, figs. 1-5.

Description.—Shell triangular to elliptical or subcircular. Slightly transverse or length and breadth subequal. Ventral valve depressed into a sinus which begins near or slightly posterior to middle of shell and becomes deep towards front of shell, umbo erect or slightly incurved, extending much beyond that of dorsal valve. Dorsal valve much more convex than ventral, bearing a fold which becomes prominent towards front. Surface ornamented by coarse plications of which 2 usually occur in sinus, 3 on fold and about 4 on each lateral slope. The plications become obsolete towards umbo which is smooth. In some cases they are confined to marginal portion, on others they extend ¾ length of shell.

The variety *altus* was named by Calvin but does not appear to have been described by him. It differs from the typical form in being much less transverse.

Length 18 mm.; width 20 mm.

[1] Bull. Geol. Soc. Amer., vol. xxiii, 1912, p. 6.

This is one of the characteristic species of the Ithaca fauna of New York and Maryland.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Two miles west of Pawpaw, West Virginia, 1340, 1388 common; Little Orleans, 1466; Fifteenmile Creek, 1 mile above Little Orleans, 1446; Woodmont, 720, 1024, 1032; National Road west of Tonoloway Ridge; Hancock 690, 994 ?; Hancock-Harrisonville Road, 725 common, 880, 944; Millstone 795; Berkeley Springs 1058, 1080, 1163 abundant; Yellow Springs, West Virginia.

Collection.—Maryland Geological Survey.

Superfamily TEREBRATULACEA

Family TEREBRATULIDAE

Genus CRYPTONELLA Hall

CRYPTONELLA cf. EUDORA Hall

Plate LIV, Fig. 23

Cryptonella eudora **Hall, 1867, Pal. of N. Y., vol. iv, p. 398, pl. lxi, figs. 34-41.**

Description.—Shell elongate or broadly oval, terebratuliform; biconvex; ventral valve produced at the umbo which is truncated by a round foramen beneath which lie, except in advanced growth, two deltidial plates. On the interior the dental plates are well developed. The dorsal valve is subcircular and regularly convex. Surface of valves smooth or with only fine concentric striæ.

Length 20 mm.; width 20 mm.

Internal casts which seem to pertain to the species have been found in a few localities. The ventral valve shows the long dental plates, thickened pedicle-sheath and punctate shell characterizing these Devonian terebratuloids.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 4716 abundant, 4769; road up Polish Mountain from Tar Creek; Williams Road, Polish Mountain.

Collection.—Maryland Geological Survey.

Family TEREBRATELLIDAE

Subfamily TROPIDOLEPTINAE

Genus TROPIDOLEPTUS Hall

TROPIDOLEPTUS CARINATUS (Conrad)

Plate LV, Figs. 1-5

Strophomena carinata Conrad, 1839, N. Y. Ann. Geol. Rep., p. 64.
Tropidoleptus carinatus Hall, 1867, Pal. of N. Y., vol. iv, p. 407, pl. lxii, figs. 2, 3.
Tropidoleptus carinatus Hall and Clarke, 1894, Pal. of N. Y., vol. viii, pt. ii, pl. lxxxii, figs. 26-36.

Description.—Shell concavo-convex, semielliptical in outline, hinge-line straight often equalling the width of the valves. Ventral valve convex. Dorsal valve moderately concave, sometimes nearly flat. Cardinal area narrow on both valves. Cardinal process of the dorsal valve projecting into the open delthyrium of the ventral.

Surface with simple radial plications; strong and angular in youth, becoming rounded and at times duplicate with age. The median rib on the ventral valve is broader than the rest and produces a carination of the valve. On the interior the ventral valve has strong crenulated teeth which fit into similar sockets on the dorsal valve. In the latter the cardinal process is conspicuous and bilobed. The loop consists of two slender processes uniting in front with a median septum rising from the bottom of the valve. From these two brachial processes project at points near the origin of the brachidium. Shell substance highly punctate.

The Maryland forms of this interesting brachiopod do not differ in any material respect from the usual forms occurring with profusion in the shales of the Hamilton group of New York, though none have been seen which attain the maximum dimensions of the latter. The shells bear 12-16 simple plications on either side of a large median plication on the ventral valve and median depression on the dorsal. Interiors show the strong crenulated teeth of the ventral valve and the similarly crenulated sockets of the opposite valve.

Length 13 mm.; width 15 mm.

In the Ithaca beds of New York the species occurs with other continuing members of the Hamilton fauna but it is with great rarity that

it has been recorded there after the introduction of *Spirifer disjunctus* and the proper Chemung fauna.

This species, which according to Williams is the most prominent member of the Hamilton fauna, occurs in the Jennings at two horizons, the Parkhead and the lower conglomerate zone of the Chemung. It is very profuse locally in the Parkhead, associated with many other recurrent Hamilton species. It is less profuse, though locally abundant, in the upper horizon, where it is also associated with recurrent Hamilton species.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Two and three-quarters miles southwest of Round, West Virginia; Mann, Pennsylvania; vicinity of Pawpaw and Magnolia, West Virginia; northeast of Pratt; Town Creek, 2691. PARKHEAD MEMBER. Rocky Run; roadside, 1 mile north of Rocky Run; Williams Road, east of Cumberland, 1466 abundant; Williams Road, on Polish Mountain, 1289 abundant, 1352, 1371 common, 1422, 1632, 1660 abundant; National Road, on Polish Mountain, 1196; 2 miles north of mouth of Town Creek, 1282, 1350, 1642, 1723 abundant, 1842 abundant, 1917 common; Town Creek, 1605, 1679, 1863 abundant; 2 miles west of Pawpaw, West Virginia, 1795 common; Little Orleans; Fifteenmile Creek, 1 mile north of Little Orleans, 1714 abundant, 1746 abundant, 1773; Sideling Hill Creek, 2½ miles above mouth, abundant; Woodmont, 1385; Hancock, 1600; Millstone, 1772; Berkeley Springs, West Virginia, 1769 abundant.

Collection.—Maryland Geological Survey.

Superfamily SPIRIFERACEA

Family ATRYPIDAE

Genus ATRYPA Dalman

ATRYPA RETICULARIS (Linné)[1]

Plate LV, Figs. 6-11

Description.—This well-known species, the most widely diffused and longest lived of all known organisms, is represented in the Maryland

[1] For full illustration and synonymy of the Chemung form of this species see Hall, Pal. of N. Y., 1867, vol. iv, p. 316, pl. liii, figs. 3-19, and Hall and Clarke, *Idem.*, 1894, vol. viii, pt. ii, pl. lv, figs. 1-17.

Chemung fauna by shells which attain considerable dimensions, with depressed or slightly convex ventral valves and highly convex, rotund dorsal valves and with the surface rather coarse ribbed and bearing strong distant concentric varices extended into free lamellæ though these lamellæ are seldom shown. The expression of the species is the same as that under which it appears in the Ithaca and Chemung rocks of New York.

On the interior the ventral valve bears large flabellate diductor scars surrounding an elongate cordiform median scar. This muscular surface is surrounded by a pustulose pallial area. The teeth are elongate, divergent and crenulate on their outer surface and on the dorsal valve the dental grooves of the hinge plate are similarly crenulated. The muscle scars in the dorsal valve are quadripartite and usually obscure.

Length 25 mm.; width 32 mm.

This species is locally abundant in the Ithaca, less frequent in the Parkhead and Chemung.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road west of Frostburg; Oakland-Altamont Road; Trout Run section; Oakland-Redhouse Road; near Ellerslie, Pennsylvania; Williams Road, on Polish Mountain, 2042; Town Creek, 3384, 3453. PARKHEAD MEMBER. Williams Road, on Polish Mountain, 1660; 2 miles west of Pawpaw, 1794; 2½ miles above mouth of Sideling Hill Creek. WOODMONT MEMBER, ITHACA FAUNA. Woodmont 500; Hancock 690 common; Hancock-Harrisonville Road, 726, 880 abundant, 944 abundant, 988; Berkeley Springs, West Virginia, 712 abundant, 755, 786; Yellow Springs, West Virginia.

Collection.—Maryland Geological Survey.

ATRYPA SPINOSA Hall

Plate LV, Figs. 12, 13

Atrypa spinosa **Hall, 1843, Geol. of N. Y. Rept. 4th Dist., p. 200, figs. 1, 2.**
Atrypa spinosa **vel. *aspira* Hall, 1867, Pal. of N. Y., vol. iv, p. 322, pl. liiia, figs. 1-14, 18, 24, 25.**
Atrypa spinosa **Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 311, figs. 391, 392.**

Description.—"Shell robust, suborbicular or ovoid; width greater or less than the length; radiatingly costate and concentrically lamellose or spinose; hinge-line often nearly straight, a little less than the width of the shell.

"Ventral valve depressed-convex, becoming more convex in the upper part; nearly flat and often a little concave towards the lateral margins, and cardinal extremities depressed or broadly sinuate in front; beak abruptly rounded; apex truncate and perforate, closely appressed and overlapping the umbo of the opposite valve.

"Dorsal valve convex, becoming gibbous in old shells, flattened or slightly concave towards the cardinal angles, regularly curving to the sides and basolateral margins, and a little elevated in front, but without any distinct mesial fold.

"Surface marked by strong rounded radiating costæ bifuracting at unequal intervals, which are much stronger in the middle of the valve, and become obsolete or appear as gentle undulations toward the cardinal angles. In the middle of the valves there are about seven or eight of these costæ in the space of half an inch. The shell is also marked by strong concentric lamellæ, which are often about a line apart. In perfect shells these lamellæ, at the crossings of the costæ, are often produced into tubular spines, which, when worn off, leave the ordinarily lamellose surface. The spaces between these projecting lamellæ are marked by fine thread-like striæ.

"In the separated valves, the hinge-line is often nearly straight, the muscular area of the ventral valve is short and broad, the length from the apex being about equal to the width. There is a slight thickening of the shell at the base of the rostral cavity. The surface around the muscular area is papillose, and limited by a thickened border, except in front, where it is discontinued. Fine vascular markings are sometimes visible near the margin. In the dorsal valve there is a thickened septum in the upper part of the muscular area.

"The spires of full-grown individuals show about fifteen turns in each." Hall, 1867.

Length 22 mm.; width 23 mm.

This species differs from *A. reticularis* in its coarser, more nodose plications.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Oakland-Redhouse Road; Trout Run section; Williams Road, on Polish Mountain, 2483, 2708; National Road, on Polish Mountain, 2706, 2949; Town Creek, 3384; Ellerslie, Pennsylvania, 1316, 1474 abundant, 1519 abundant. WOODMONT MEMBER, ITHACA FAUNA. Two miles west of Pawpaw, West Virginia, 1388.

Collection.—Maryland Geological Survey.

ATRYPA HYSTRIX Hall

Plate LV, Figs. 14-19

Atrypa hystrix **Hall, 1843, Geol. of N. Y., Rept. 4th Dist., p. 27, fig. 2.**
Atrypa hystrix **Hall, 1867, Pal. of N. Y., vol. iv, p. 326, pl. liiia, figs. 15-17.**
Atrypa hystrix **Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 311, fig. 392.**
Atrypa hystrix **Cleland, 1911, Bull. xxi, Geol. Survey, Wis., p. 73, pl. xlii, figs. 14-16.**

Description.—Associated with the usual form of *Atrypa reticularis* already considered occur Atrypas of large size with broad and few plications crossed by projecting concentric lamellæ. These lamellæ present the aspect of a crenulated frill and where they cross the plications project outward as a free fold, or these expressions may be so infolded at the sides as to produce hollow spines. The spinous shell is the typical expression of the original *A. hystrix* of the Chemung and the *A. spinosa* of the Hamilton stage,[1] while to the spineless but scraggy shell of the New York Chemung with these few plications Hall originally applied the European (Schlotheim's) term *aspera*, subsequently calling the Iowa shell, which is relatively plumper and more gibbous, *A. aspera* var. *occidentalis*. With a large number of representatives of all these expressions of surface it is difficult to determine how the names are to be restricted, as the passage of the frilled lamellæ into hollow spines can often be observed in the individual shell and yet in the main the expressions of the shells indicate their

[1] The allied form from the middle Devonian of Iowa, *A. hystrix* var. *occidentalis* Hall. is described and figured in Geology of Iowa, 1858, vol. i, pt. ii, p. 515, pl. vi, fig. 3.

geologic position. Following Schuchert in eschewing the term *aspera* as not applicable to our Devonian species the writer includes under one term the Chemung species which have been generally known as *A. aspera* and *A. hystrix,* the latter presenting the spinous senile or genetic condition of the former in the same manner as the Hamilton species *A. spinosa* shows a like but much more accelerated condition of a more finely ribbed Atrypa.

In the broad sense, therefore, the term *hystrix* is applied to these large rough-shelled Atrypas of the Maryland Chemung. Shells with highly convex dorsal valves, very shallow ventral valves, bearing seldom more than 8-10 plications with sometimes only 3 or 5 obscure ones visible. Among the concentric frills on the surface of these shells occasionally a single fold forms a spine, or a given frill a row of such infolded tubular extensions, though none seem to have attained great length. The relation of these shells to those of *Atrypa reticularis* is seen upon comparison of the early growth stages of the two. The sparsely ribbed infantile or nepionic condition of *A. reticularis* is continued throughout the life of *A. hystrix,* which in this respect is an instance of arrested development, while in company with this life-long, infantile condition is the attainment of great size, and the early manifestation of such senile traits as the excessive exudation of test substance in the form of excrescences. With reference then to *A. reticularis, A. hystrix* is an overgrown and senile infant, the degenerate offshoot of an expiring race.

Length 30 mm.; width 35 mm.

This species is restricted to higher horizons while *A. spinosa* is more usual at lower horizons.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road west of Frostburg; Oakland-Altamont Road; Oakland-Redhouse Road; Trout Run 2 miles south of Oakland; on the road from Oakland to Deer Park; in the vicinity of Cherry Creek and of Deer Park Station; in the railroad cut at Altamont; Allegany Grove, 2215; Ellerslie, Pennsylvania, 1316; Town Creek 4769; at many outcrops in the Polish Mountain sections along the National and the Williams roads; one-half mile east of Millstone Point; and just west of Tonoloway Hill.

Collection.—Maryland Geological Survey.

Family SPIRIFERIDAE

Genus CYRTINA Davidson

CYRTINA HAMILTONENSIS Hall

Plate LVI, Figs. 1-3

Cyrtina hamiltonensis Hall, 1857, 10th Rept. N. Y. State Cab. Nat. Hist., p. 166.

Cyrtina hamiltonensis Hall, 1867, Pal. of N. Y., vol. iv, p. 268, pl. xliv, figs. 26-33, 38-52.

Cyrtina hamiltonensis Hall and Clarke, 1894, Pal. of N. Y., vol. viii, pt. ii, pl. xxviii, figs. 23-33, 43, 45, 46, 53.

Cyrtina hamiltonensis Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 313, figs. 393.

Cyrtina hamiltonensis Cleland, 1911, Bull. xxi, Geol. Survey Wis., p. 75, pl. xv, figs. 7-10.

Description.—Shell small, trihedral with erect or incurved ventral beak, high vertical or incurved cardinal area and elongated deltidium. Median sinus and fold strongly developed; lateral slopes with 6 to 8 rounded ribs crossed by fine concentric striæ. On the interior of the ventral valve the dental plates along the bases of the deltidium are highly developed, converge toward each other and unite with the sides of a very strong median septum arising from the bottom of the valve.

This species which takes its name from its occurrence in the Hamilton fauna of New York, ranges upward in that State into the Ithaca fauna. Its variations in form in both of these New York faunas are found in the size of the shells, the curvature of the ventral valve and cardinal area and the angularity of fold and sinus. Some shells could probably be referred to the small erect shell of New York which Hall distinguished by the varietal term *recta* and which occurs in both Hamilton and Ithaca faunas.

The Maryland shells are casts showing the long median septum of the ventral valve supporting a spondylium or spoon-shaped process formed by the convergence and union of the dental plates. The cardinal area is high and variously curved; the plications are from 4 to 7, those near the hinge being faint; the hinge-line is straight and sometimes slightly extended at the extremities.

Length 15 mm.; width 15 mm.

This is a common species in the Ithaca fauna. It is less frequent in the Parkhead and rare in the Chemung.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Between Oakland and Deer Park; Town Creek, 2033, 2228; Pennsylvania state line, west of Green Ridge, in upper *Tropidoleptus zone.* PARKHEAD MEMBER. Allegany Grove 850; Rocky Run; Williams Road, on Polish Mountain, 1660; 2 miles north of mouth of Town Creek, 1842; Sideling Hill Creek 2½ miles above mouth. WOODMONT MEMBER, ITHACA FAUNA. Two miles west of Pawpaw, West Virginia, 1340 abundant, 1388 common; east of Little Orleans, 1446; Fifteenmile Creek, 1 mile above Little Orleans, 1446 abundant; Woodmont, 1024, 1032 common, 1067; National Road west of Tonoloway Ridge; Hancock, 1149 to 1274 common; Millstone, 1122 common; Berkeley Springs, West Virginia, 1163 abundant; Yellow Springs, West Virginia, 629 abundant, 665.

Collection.—Maryland Geological Survey.

Genus RETICULARIA McCoy

RETICULARIA LÆVIS (Hall)

Plate LVI, Figs. 4-6

Delthyris lævis Hall, 1843, Geol. N. Y., Rept. 4th Dist., p. 245, fig. 1.
Spirifer lævis Hall, 1867, Pal. of N. Y., vol. iv, p. 239, pl. xxxix, figs. 1-12.
Reticularia lævis Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, p. 343.
Recticularia lævis Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 339, fig. 432.

Description.—"Shell ventricose, subcircular or semielliptical, with the cardinal extremities rounded; length and breadth as two to three, or three to four; not plicate.

"Ventral valve ventricose; the greatest convexity above the middle, from whence it curves gently to the base and suddenly towards the beak, which is abruptly attenuate and arching over the area; sinus variable, often shallow, gently concave and scarcely defined; sometimes becoming deep, subangular, and very broad in the lower part. Area extending to the hinge-extremities, of moderate height at the sides and rising abruptly towards the middle; foramen partially closed by an arching, very convex pseudo-deltidium.

"Dorsal valve depressed or moderately convex, with a wide and usually undefined mesial fold which is much expanded below, leaving the anterior margin sinuate; sides of the shell somewhat regularly curving, and a little flattened at the cardinal extremities.

"Surface usually smooth, or marked only by concentric lines of growth. In older shells there are sometimes a few obscure and undefined radiating folds.

"The interior of the ventral valve shows strong short teeth with the dental lamellæ much thickened, filling up the rostral cavity and extending along the sides of the upper part of the muscular impression; the muscular space is of small or of moderate size, deeply marked, and often preserving a distinct median crest.

"In the dorsal valve the muscular impression is small and narrow, and usually not deeply marked. The cardinal process is strongly striated, and this character is distinctly preserved in the cast." Hall, 1867.

Length 20 mm.; width 28 mm.

The occurrence of this species in Maryland is of much interest since it is one of the most important members of the Ithaca fauna of New York where it is restricted to two horizons, one near the base and a second near the top of the beds containing that fauna.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Hancock, 690 abundant, 935; Berkeley Springs, West Virginia, 712 abundant, 755.

Collection.—Maryland Geological Survey.

Genus SPIRIFER Sowerby

SPIRIFER DISJUNCTUS Sowerby[1]

Plate LVI, Figs. 7-14; Plate LVII, Fig. 1

Spirifer disjunctus Sowerby, 1840, and *Sp. verneuili* Murchison, 1840, and of authors generally.

Description.—Among Devonian Spirifers no species is better known or so widely distributed as this. Throughout the world wherever later

[1] For extended synonymy and illustrations of American forms see Pal. of N. Y., 1867, vol. iv, p. 243, pls. xli, xlii; also Pal. of N. Y., 1894, vol. viii, pt. ii, pl. xxx, figs. 14-17.

Devonian deposits occur it has been regarded as indicating an upper Devonian horizon. Its range through this division of the Devonian, however, varies in different countries and sections. Where the life zones are best defined, as for example in New York where this later stage of Devonian (the horizon of *Rhynchonella cuboides* (Cuboides zone=Tully limestone)) is followed by that of *Manticoceras intumescens* (Intumescens zone=Naples beds) and this by the Chemung fauna with *S. disjunctus*. Here its lower range is more restricted than in certain of the sections in Devon, Germany and Russia, in which the species appears with the initiatory upper Devonian fauna. In New York, on the other hand, the species rises into strata which show a marked change in the fauna and the ingress of later, that is post-Devonian types, and it is assumed that here at least the species continues beyond the migration or extinction of its normal faunal associates, and becomes thus what has been termed a "superstitial" or surviving species.

Spirifer disjunctus may be at once distinguished from other Devonian Spirifers of this age by the fine ribs on its fold and sinus. However it may vary in its form and proportions from a short, winged, plump shell to a narrow, slender form with greatly extended cardinal angles, this feature abides as its distinguishing character. Its associate *S. mesastrialis* has fine lines on fold and sinus and *S. mesacostalis* a single more or less defined median rib in the sinus. No other Devonian species approach it or are a source of confusion with it.

It will be observed from the illustrations cited and here given how much the shell varies in its aspect, and some of the expressions are peculiar to the locality at which they are found, but there is not enough evidence to show that any is confined to a given horizon or dissociated at any spot with other expressions of the species. All attempts, therefore, that have been made to ascribe a zonal value to these various expressions of the species have been attended with little success, and the various designations at one time applied by Hall to such expressions have been for the most part withdrawn from usage at the instance of that author himself.

The species is of relatively rare occurrence in the lower beds of the Chemung of New York, and in the New York succession culminates after

the culmination of *Spirifer mesastrialis* and *S. mesacostalis*. *Douvillina cayuta,* also a species which in New York is most abundant in the earlier Chemung sediments and, as has been observed, attains remarkable profusion and variety in the Maryland strata, is only an occasional associate of the species in New York. Generally speaking, shells of the form represented in fig. 8 are of the most common expression in Maryland and New York, short wings with margins broadly rounded to the median sinus. The extension of cardinal angles shown in figs. 10 and 11, is also of frequent occurrence; fig. 1, pl. lvii, represents an extreme condition. A noteworthy expression is shown by the shells found in green shale on Polish Mountain where some are short hinged and some long hinged (fig. 10) but all have the margins of the median sinus not rounded but quite strongly elevated, a feature persistent irrespective of variation in form. This expression is also seen in some specimens from other localities.

The careful study of the variations of this plastic species may eventually disclose the significance of these expressions, whether of geographical or zonal value. The usefulness of such an undertaking will be further shown in determining how far the later expressions of the species pass into those species of recognized carboniferous. shells bearing similar features, of which *S. newberryi, imbrex* and *marionensis* may be cited among the American forms. Until this latter task is done it remains unsafe to carry the Devonian line upward to whatever extent the species may seem to run.

Length 20 mm.; width 40 mm.

This species is characteristic of and coextensive with the Chemung of Maryland. It is found at nearly all exposures of that member. Some of the observed horizons are recorded in the following paragraph.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Allegany Grove, 1363, 2325, 2340, 2355, 2380 abundant, 2800, 2960 abundant, 2980 abundant, 3000 abundant; Ellerslie, Pennsylvania, 1316 abundant, 1474 abundant; Williams Road, Polish Mountain, 1967, 2382, 2708, 2725; National Road, on Polish Mountain, 2016, 2185, 2949; 2 miles north of mouth of Town Creek, 1949; Town Creek, 2122 abundant, 2228 abundant, 2496 abundant, 3982 abundant, 4480 abundant, 4562,

4596, 4631, 4716 abundant, 4769 abundant; 2 miles west of Pawpaw, West Virginia, 2124 abundant, 2190, 4564 abundant, 4694; Fifteenmile Creek, 1 mile above Little Orleans, 2216, 2286; National Road, on Green Ridge, 1850; Woodmont, 1667; Hancock, 2275; Millstone 2390 abundant, 2440, 2919; National Road, 5-7 miles west of Frostburg; Oakland-Altamont Road; Green Glade Run; various places near Oakland and Deer Park; vicinity of Trout Run; near top of Chemung east of Barrelville; Wills Creek Station, Pennsylvania.

Collection.—Maryland Geological Survey.

SPIRIFER MESASTRIALIS Hall

Plate LVII, Figs. 2-5

Spirifer mesastrialis Hall, 1867, Pal. of N. Y., vol. iv, p. 242, pl. xl.
Spirifer mesastrialis Hall and Clarke, 1894, *Ibid.*, vol. viii, pt. ii, pl. xxxvii, figs. 4, 5.
Spirifer mesastrialis Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 332, fig. 423.

Description.—This Spirifer is characterized by the fine radial lines which cover fold and sinus and also traverse the numerous flattened lateral plications and furrows of the valves. At times these lineations become interrupted, specially near the margins of the median part of the shell and appear as radial series of elongate pustules. The form of the valves is quite variable, sometimes short on the hinge, plump and round, again with elongated cardinal extremities; the size of the shell prevailing at a given locality may be large, medium or small, but for all these variations the laws governing their manifestations have not yet been ascertained. Among them all it is usual to find the plications, 10 to 15 in number, moderately broad and flattened, with narrow furrows and fold and sinus low and near the anterior margin very broad. Concentric markings or growth lines are usually absent.

Length 25 mm.; width 45 mm.

The figures we have given show the characteristic expression of this shell in Maryland. In New York the species is a survivor from the fauna of the Ithaca where it is introduced into that fauna soon after its return to the field it held before the close of Hamilton time. In the middle

and upper beds of the Ithaca formation it attains its greatest abundance but continues its existence through the earliest manifestations of the Chemung fauna.

In Maryland this species is very rare in the Ithaca and Parkhead, but abundant in the Chemung, ranging from the base of the latter member to the upper conglomerate.

Occurrence.—Jennings Formation, Chemung Member. National Road, west of Frostburg; section on Trout Run; Bear Pen Run; Ellerslie, Pennsylvania, 1508; Little Run, 1/2 mile west of Wills Creek Station, Pennsylvania; National Road, on Polish Mountain, 2706, 2929, 3036; Town Creek, 2122, 2228 common, 2450, 2913, 3404, 3453 common, 3584 ?, 3593, 3963 small; 2 miles west of Pawpaw, West Virginia, 2190 ?, 3540; top of Green Ridge; Fifteenmile Creek, 1 mile above Little Orleans, 2286 abundant; east of Baird on B. & O. R. R., Bellegrove, 300 feet west of Schoolhouse, abundant; Sideling Hill Creek; National Road, west of Tonoloway Ridge; Hancock, 2223, 3406 abundant; Millstone, 2345, 2390, 2444 abundant, 2470, 2749 abundant, 2761, 2796; Berkeley Springs, West Virginia, 2158 abundant. Parkhead Member. Two miles north of mouth of Town Creek, 1723; 2 miles west of Pawpaw, West Virginia; Millstone, 1672, 1694, 1811 abundant, 1916; Berkeley Springs, West Virginia, 1554 to 1566. Woodmont Member, Ithaca Fauna. Hancock, 1149 to 1274; Yellow Springs, West Virginia, 734.

Collection.—Maryland Geological Survey.

Spirifer marcyi var. superstes n. var.

Plate LVII, Figs. 6-11

Description.—*Spirifer marcyi* is a species which occurs with some frequency in the soft calcareous shales of the Hamilton group at certain localities in western New York and was described and fully illustrated by Prof. Hall in vol. iv, Paleontology of New York, p. 226, pl. xxxvii, figs. 10-20. The species is characteriized by its broad, many-ribbed lateral slopes, each full-grown shell bearing about 30 flattened plications on each of these slopes; low, smooth fold and sinus, and having the surface of pli-

cations, fold and sinus covered with elongated pustules or spine bases and the plication generally marked by a fine median line.

Allied to *Spirifer marcyi* but distinguished therefrom in its high erect cardinal area, shorter hinge and fewer plications is the species *Spirifer asper* Hall, originally described from a middle Devonian horizon in Iowa (Rockford and other localities) but also known to occur in the Hamilton fauna of New York.

To both of these shells some of the specimens from the Maryland Chemung are closely related. They show the long lateral slopes of *S. marcyi* and the largest of them indicating full growth bear 30 plications, which are fine, simple and not crossed by concentric growth lines. The surface is distinctly granulose, or sometimes pitted over the fold and sinus and along the plications. The latter are narrower than in *S. marcyi* and have more nearly the width of the separating furrows. In specimens from the Chemung the cardinal area is high and erect, in which respect the shell is more like *Spirifer asper*. In individuals from the Parkhead the area is not so high and the expansion of the shell is more normal. The length of the larger shells along the hinge is 50-60 mm. The unusual occurrence of a Spirifer of this type in the upper Devonian of the interior province, a fact not hitherto noted in this region, is worthy of special record as another instance of the survival of Hamilton specific types into later faunas which is so emphatically illustrated by the fauna of the Ithaca beds. We have, therefore, designated the shell by the mutational term *superstes*.

This recurrent Hamilton species is abundant in the more westerly exposures of the Parkhead and in the upper *Tropidoleptus zone* of the Chemung. The variety *superstes* is best characterized in the higher zone.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Upper *Tropidoleptus zone,* 2¾ miles south of Round, West Virginia; National Road, Polish Mountain above 6th turn; Town Creek, 2691 common; National Road, on Green Ridge, 2690 abundant. PARKHEAD MEMBER. Williams Road, east of Cumberland, 1466 abundant; Rocky Run abundant; road 1 mile north of Rocky Run; Williams Road, on Polish Mountain, 1660 abundant; National Road, 1196, 1625; 2 miles north of mouth

of Town Creek, 1723; Town Creek, 1863; 2 miles west of Pawpaw, West Virginia, 1794 abundant; 2½ miles north of mouth of Sideling Hill Creek common.

Collection.—Maryland Geological Survey.

SPIRIFER MUCRONATUS VAR. POSTERUS Hall and Clarke

Plate LVIII, Figs. 1-10

Delthyris mucronata Hall, 1843, (in part), Geol. N. Y., Rept. 4th Dist., p. 270, fig. 3.

Spirifer mucronatus var. *posterus* Hall and Clarke, 1893, Pal. of N. Y., vol. viii, pt. ii, p. 361, pl. xxxiv, figs. 27-31.

Description.—Shell semicircular to triangular; cardinal angles mucronate, extremities often greatly extended; hinge-line attaining a length of two, three or more times that of shell; sides straight or curving, usually oblique, or occasionally nearly at right angles to hinge-line. Hinge-line straight. Area narrow triangular.

Ventral valve often but little more convex than dorsal, in other specimens more gibbous. Umbo small, incurved over area. Mesial sinus broad in front, extending to apex, limited by two plications which may be more prominent than others. Sinus deep, often quite wide in front, in some specimens simple, in others bearing a low plication in center, the position of which is indicated in a few individuals simply by a retral curvature of the laminæ. Dorsal valve usually moderately convex; fold prominent, often wide in front, bearing, in most individuals, a median groove.

Surface ornamented by about 10 to 15 rather coarse angular plications which are obsolete on the mucronate extensions; plications crossed by numerous imbricating lamellæ which are often crowded in front. Young specimens, when very well preserved, are seen to be ornamented by fine, interrupted, radiating striæ. These striæ are but faintly visible in adult specimens and are seen only in unusually well-preserved individuals.

Interior of ventral valve bears short teeth, scarcely noticeable in cast, and a striated muscular area in the center of which are small elongate scars for the attachment of the adductor muscles. Median septum absent or represented by a very faint line.

Length 15-20 mm.; width 35-60 mm.

The presence of fine interrupted radiating striæ has not been noted in the published descriptions of this form but H. S. Williams informs the writer that they are observed in well-preserved species of *S. mucronatus, S. mucronatus* var. *posterus,* and *S.* (*Delthyris*) *mesacostalis* in New York.

This variety is subject to considerable variation in size and form. The specimens observed in the lower beds containing the Ithaca fauna in Maryland are small and, so far as seen, without a median plication in the sinus, agreeing closely with those found in the Ithaca fauna of central New York. In the *Liorhynchus globuliforme zone* the specimens attain a much larger size than is usual in individuals in central New York, while some possess a plication in the bottom of the sinus, a feature not seen in the New York forms. The latter feature is, however, not constant. Some specimens have the lateral margins nearly at right angles to the hinge-line being then identical with a form described as *S. dactylus* by H. S. Williams from the *Liorhynchus globuliforme zone* of eastern New York. These modifications are so closely connected by transitional forms in Maryland that it has not seemed possible to discriminate them by varietal names. All are clearly mutations of *S. mucronatus* of the Hamilton.

This variety may closely approach *S. mucronatus* in its general proportions. Usually, however, the specimens are somewhat smaller and possess more extended cardinal angles upon which the plications are obsolete.

The variety also closely approaches *S.* (*Delthyris*) *mesacostalis* in its external features, but differs in the absence of a median septum in the interior of the ventral valve. A few individuals have been observed possessing a very rudimentary septum suggesting a transition to the latter species.

This is one of the most abundant and characteristic species of the Ithaca fauna of Maryland and adjacent areas. In several localities it may recur in the Tropidoleptus fauna of higher horizons though it is very rare and the stratigraphic relations are obscure or identification is insecure in these cases. When assuredly identified it is confined to the Ithaca fauna.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Near Pennsylvania-Maryland line west of Green Ridge in upper Tropidoleptus horizon ?. PARKHEAD MEMBER. Two miles north of mouth of Town Creek, 1842 ?, 1949 ?; 2 miles west of Pawpaw, 1612 ?. WOODMONT MEMBER, ITHACA FAUNA. Two miles west of Pawpaw, 1340 abundant; Little Orleans, 1446; Fifteenmile Creek, 1 mile above Little Orleans, 1446; Woodmont, 710, 776, 1024, 1032 abundant, 1067, 1285; National Road west of Tonoloway Ridge; Hancock 690, 935, 994 ?, 1149 abundant, 1274 abundant, 1149 to 1274 abundant; Hancock-Harrisonville Road, 726, 880 abundant, 944; Millstone 1057, 1122, 1141, 1148; Berkeley Springs, West Virginia, 712, 755, 1010, 1058, 1074, 1080 abundant, 1163, 1371 abundant; Yellow Springs, West Virginia, 629, 665, 734 abundant.

Collection.—Maryland Geological Survey.

SPIRIFER (DELTHYRIS) MESACOSTALIS Hall

Plate LVIII, Figs. 11-23; Plate LIX, Figs. 1, 2

Spirifer mesacostalis Hall, 1867, Paleontology of New York, vol. iv, p. 240, pl. xl, figs. 1-13.

Spirifer mesacostalis Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 332, fig. 424a.

Description.—This species resembles *S. mucronatus* externally but differs in possessing a distinct median septum in the ventral valve. While the cardinal angles are ordinarily simply acute in some cases the extremities are greatly extended, increasing the resemblance of the species to *S. mucronatus*. The presence of a median septum in the interior, however, affords a distinct criterion for the separation of the two forms. This species is exceedingly abundant in the Parkhead and continues common to the upper conglomerate of the Chemung, above which it is less frequent.

Length 15-20 mm.; width 30-40 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road west of Frostburg; Oakland-Altamont Road; Oakland-Redhouse Road; Trout Run section; Allegany Grove, 1153 ?, 1250 abundant ?, 1310 abundant, 1520, 2020, 2111, 2340; Ellerslie, Pennsylvania, 1316 abundant, 1474; Williams Road, on Polish Mountain, 2382 abundant,

1708 abundant, 1725, 3009; National Road, on Polish Mountain, 2016, 2159, 2706 common, 2929 abundant, 2949; Town Creek, 3384, 3404, 3453, 3584, 2 miles west of Pawpaw, West Virginia, 2190; National Road, on Green Ridge, 3400; Millstone, 2253 ?, 2322. PARKHEAD MEMBER. Rocky Run; Turners Road, 7 miles southeast of Cumberland; Williams Road, east of Cumberland, 1393 ?; Williams Road, on Polish Mountain, 1289, 1524, 1632, 1660 common; National Road, on Polish Mountain, 1196, 1625; 2 miles north of mouth of Town Creek, 1723 common, 1917 common, 1949; Town Creek, 1729, 1863 abundant; 2 miles west of Pawpaw, West Virginia, 1612, 1794 common; east of Little Orleans; Fifteenmile Creek, 1 mile north of Little Orleans, 1713, 1746, 1766 common, 1774; Sideling Hill Creek 2½ miles above mouth, abundant; National Road west of Tonoloway Ridge; Hancock, 1600; Millstone, 1600; Berkeley Springs, West Virginia, 1769; Yellow Springs, West Virginia, 1600.

Collection.—Maryland Geological Survey.

Genus AMBOCOELIA Hall

AMBOCŒLIA UMBONATA (Conrad)

Plate LIX, Figs. 3-7

Orthis umbonata **Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 264, pl. xiv, fig. 21.**

Ambocœlia umbonata **Hall, 1867, Pal. of N. Y., vol. iv, p. 259, pl. xliv, figs. 7-18.**

Ambocœlia umbonata **Hall and Clarke, 1894, Pal. of N. Y., vol. viii, pt. ii, pl. xxix, fig. 17; pl. xxxix, figs. 4-9.**

Ambocœlia umbonata **Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 343, fig. 438.**

Description.—Shell small, convexo-plane, suborbicular in outline. Ventral valve gibbous with umbo elevated and incurved. Median sinus distinct. Cardinal area arched. Dorsal valve depressed convex or flat. Surface of both valves smooth or marked only with fine concentric striæ. On the interior, the ventral valve has strong teeth, the dorsal valve has strong crural plates and a quadripartite muscular scar situated in front of the middle.

Length 6 mm.; width 6 mm.

This little shell is very widely diffused through the Maryland Chemung strata; frequently heaped together in masses which constitute thin seams through the sandy matrix. So far as can be ascertained the species shows no deviation from its usual expression and there is no evidence to indicate the propriety of applying to this shell the varietal name *gregaria* used by Hall for the Chemung form. The curved, arched ventral valves show a sharply defined median groove and the rotund lateral slopes bear only traces of concentric striæ. The dorsal valves are gently convex about the umbo, and flattened or depressed toward the margins. The interior characters are often well preserved on the casts showing the peculiar muscular scars of the dorsal valve and the deep pedicle impression of the ventral valve. It has been difficult, on account of this mode of preservation, to obtain well-defined impressions of the exterior of the shells.

This species is very abundant in the Chemung but rarely occurs below that horizon. The first incoming of the Chemung fauna is usually indicated by a profuse development of this form in beds which lie a short distance below the lowest beds containing *Spirifer disjunctus,* while it continues to be abundant in the higher horizons. The lowest beds containing *Ambocœlia umbonata* are here considered to be a part of the Chemung.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Oakland-Altamont Road; Deer Park; Mountain Lake Park; Oakland-Redhouse Road; Trout Run section; Allegany Grove 1153 ?, 1250 abundant, 1310 abundant, 2076 abundant; Ellerslie, Pennsylvania, 1474 abundant; 2¾ miles south of Round, upper *Tropidoleptus zone,* abundant; Williams Road, on Polish Mountain, 1837; National Road, on Polish Mountain, 1957, 2503; near Pennsylvania-Maryland state line west of Green Ridge in upper *Tropidoleptus zone* ? abundant; Town Creek, 2023 abundant, 2122, 2691 abundant, 2750, 3384, 3453; Fifteenmile Creek, 1 mile above Little Orleans, 2215; National Road, on Green Ridge, 3400 abundant; Woodmont, 1667; Hancock, 2223 abundant; Millstone, 2225, 2322 common. WOODMONT MEMBER, NAPLES ? FAUNA. Allegany Grove, 475.

Collection.—Maryland Geological Survey.

Family ATHYRIDAE

Genus ATHYRIS McCoy

ATHYRIS ANGELICA Hall

Plate LIX, Figs. 8-10

Athyris angelica **Hall, 1861, 14th Rept. N. Y. State Cab. Nat. Hist., p. 99.**
Athyris angelica **Hall, 1867, Pal. of N. Y., vol. iv, p. 292, pl. xlvii, figs. 9-20.**

Description.—"Shell ovoid, gibbous, transverse or elongate; proportions of length and width variable, the prevailing form longer than wide; deeply sinuate, with the beak very prominent; hinge-line short.

"Ventral valve gibbous, most convex above the middle; mesial sinus usually extending nearly to the beak, becoming abruptly and deeply depressed below the middle, and much expanded towards the front of the shell; lateral portions of the valve gibbous, and abruptly curving towards the margins; beak much elevated and curved over the umbo of the dorsal valve.

"Dorsal valve much shorter than the opposite, gibbous, transverse or as long as wide; the mesial fold usually not conspicuous above the lower third of the valve; in the upper part the surface is a little more gibbous, and the striæ along this part are more straight or a little curved backwards, indicating the form during the successive stages of growth.

"Surface marked by regular equidistant imbricating lamellæ or lamelliform striæ, the edges of which in perfect specimens are projecting and slightly crenulate. These lamellæ are marked by short interrupted radiating striæ.

"The interior of the ventral valve shows a semicircular perforation at the apex, opening on the lower side to a triangular fissure. The teeth are strong, and continued in plates to the base of the rostral cavity, and divaricator imprints occupy an ovate space below and on each side. Surface of cast, adjacent to the muscular imprints, strongly papillose.

"The muscular imprints of the dorsal valve are not well preserved in any specimens in my collection. There is a slender longitudinal septum

extending from the beak for one-half the length of the valve." Hall, 1867.

Length 17 mm.; width 20 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Allegany Grove, 2941.

Collection.—Maryland Geological Survey.

Genus MERISTELLA Hall

MERISTELLA HUMILIS n. sp.

Description.—Shell broadly ovate, width somewhat greater than length, umbo prominent, hinge-line short. Ventral valve convex, point of greatest convexity posterior to middle; depressed in front to form a shallow sinus; slightly concave towards lateral margins, greatest width near middle. Beak nearly straight, projecting beyond that of dorsal valve. A slightly angular ridge extends from beak to extremity of hinge, the surface between it and hinge being flattened or concave.. Dorsal valve broadly ovate; bearing a low fold towards front; point of greatest convexity posterior to middle; beak small.

Cast of interior shows two short dental lamellæ in ventral valve and a median septum extending nearly one-third length of shell in dorsal valve, two depressions marking position of teeth.

Surface smooth with faint concentric lines of growth.

Length of largest individual observed 10 mm.; width 12 mm.; thickness 4 mm. Only a few individuals have been seen. This species seems quite distinct from any previously described form of the genus.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Millstone, 795; Yellow Springs, West Virginia.

Collection.—Maryland Geological Survey.

MOLLUSCA

CLASS PELECYPODA

Order PRIONODESMACEA

Family GRAMMYSIIDAE

Genus GRAMMYSIA de Verneuil

GRAMMYSIA ELLIPTICA Hall

Plate LIX, Figs. 11, 12

Grammysia elliptica Hall, 1870, Notice Lammellibranchiata, vol. ii, p. 53.
Grammysia elliptica Hall, 1885, Pal. of N. Y., vol. v, pts. i, ii, p. 365, pl. lviii, figs. 1-12.

Description.—Shell transversely elliptical, basal margin broadly curving, slightly sinuate about the middle; posterior margin abruptly rounded below and curving into the cardinal line above, sometimes more or less truncate. Valves regularly convex becoming more or less gibbous in the umbonal region. Beaks subanterior, prominent, incurved; cincture extending obliquely to the base of the shell. Surface with fine irregular concentric striæ which become aggregated into fascicles at the front and middle of the shell.

Length 50 mm.; height 40 mm.

In New York it has a notable vertical range from the beds with the Ithaca fauna upward into the higher Chemung strata.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. One mile east of Barrelville near top of Chemung; Allegany Grove, 1633, 2800; Town Creek, 3870, 3963, 3969. PARKHEAD MEMBER. Town Creek, 1605; 2 miles west of Pawpaw, West Virginia, 1484.

Collection.—Maryland Geological Survey.

GRAMMYSIA SUBARCUATA Hall

Plate LIX, Fig. 13

Grammysia subarcuata Hall, 1870, Prel. Notice Lammellebr., vol. ii, p. 61.
Grammysia subarcuata Hall, 1885, pal. of N. Y., vol. v, pt. i, ii, p. 375, pl. lxi, figs. 10-22, pl. xciii, fig. 26.

Description.—" Shell of medium size, sub-ovate, widest at the posterior end; length more than one-third greater than the height; basal margin regularly convex, sometimes straight, or constricted toward the anterior end. Posterior extremity rounded, or obtusely subangular, often subtruncate above. Cardinal line nearly straight. Anterior end short, abruptly rounded below the lunule. Valves moderately convex in the lower and posterior part, becoming gibbous in the middle and umbonal region. Beaks subanterior, prominent, inclining forward and strongly incurved. Umbonal slope rounded. Postcardinal slope flattened or concave, sometimes limited by an elevation, at which line the concentric undulations terminate. Anterior to the middle of the shell, extending from the beak to the basal margin, there is a depression or cincture which often gives a slight undulation to the concentric folds and a constriction to the margin. Surface marked by fine, close concentric striæ and by strong subangular concentric ridges or folds, which are frequently duplicate posterior to the cincture. The surface is also marked by fine, radiating pustulose striæ, which are often very conspicuous. Interior unknown. Three specimens measure respectively 36, 38, and 48 mm. in length, and 20, 23, and 33 mm. in height. The largest specimen observed has a length of 70 mm. This species resembles *G. arcuata* in its general aspect, but differs in its more elongate form, more pointed posterior end, and the cincture is much more strongly marked." Hall, 1885.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road, on Polish Mountain, 2503. PARKHEAD MEMBER. Allegany Grove, 950; Williams Road, on Polish Mountain, 1289.

Collection.—Maryland Geological Survey.

GRAMMYSIA COMMUNIS Hall

Plate LIX, Figs. 14, 15

Grammysia communis **Hall, 1885, Pal. of N. Y., vol. v, pt. i, ii, p. 378, pl. lxi, figs. 24-28; pl. xciii, fig. 20.**

Grammysia communis **Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 383, fig. 27.**

Description.—" Shell small, ovate-cuneate; length less than twice the height; basal margin gently curving with a slight constriction just ante-

rior to the middle of the length, abruptly recurving at the postbasal extremity and obliquely truncate above. Cardinal line nearly straight, scarcely declining posteriorly. Anterior end short, obliquely truncate above at the lunule, and abruptly rounded below, having an angle at the junction of the two lines. Valves regularly convex in the lower and posterior portions, becoming gibbous above and especially on the post-umbonal slope. Beaks subanterior, prominent, large, strongly incurved. Umbonal slope obtusely sub-angular, and extending to the posterior extremity, with a faint indication of a plication on the postcardinal slope. Valves marked by a distinct cincture extending from the beak, more or less obliquely, to the basal margin anterior to the middle of its length. Surface marked by fine concentric striæ, which are obscurely visible in the cast; and by strong concentric undulations which mark the anterior and central portion of the valves, becoming obsolete on the umbonal ridge. Interior unknown." Hall, 1885.

Length 29-44 mm.; height 10-15 mm.

The individuals observed in Maryland differ slightly from those figured by Hall from New York though they approach them closely.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Yellow Springs, West Virginia, 665.

Collection.—Maryland Geological Survey.

GRAMMYSIA UNDATA Hall

Edmondia undata **Hall, 1883, Pal. of N. Y., vol. v, pt. ii, Plates and Explanations, pl. lxiv, fig. 30.**

Grammysia undata **Hall, 1885, Pal. of N. Y., vol. v, pt. i, ii, p. 379, pl. lxi, Fig. 23, pl. lxiv, fig. 30; pl. xciii, fig. 21.**

Grammysia undata **Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 383, fig. 28.**

Description.—"Shell below the medium size; ovate subelliptical; length about one-third greater than the height; basal margin gently curving, nearly straight, and slightly constricted anterior to the middle of its length. Posterior margin curving upward to about the middle of its height, above which it is obliquely subtruncate. Cardinal line straight, more than two-thirds the length of the shell, slightly declining posteriorly.

Anterior end short, regularly rounded. Valves regularly convex in the lower and posterior portion, becoming gibbous in the middle and above. Beaks at about the anterior third or fourth, rather prominent. Umbonal slope subangular above, and sometimes continued to the postinferior extremity. Cincture broad, undefined, extending from the beaks to the base anterior to the middle, and producing a flattening of the valve and a slight constriction of the basal margin. Surface marked by fine concentric striæ, with a few, more or less distinct, concentric undulations, which become obsolete at about the umbonal angle. Interior unknown. This species resembles *G. communis,* but the concentric undulations are not so numerous, the umbonal slope less defined, the posterior end broader and not so obliquely truncate above the middle, and the cincture more nearly vertical." Hall, 1885.

A few poorly preserved specimens have been observed which seem probably referable to the species.

Length 21-30 mm.; height 14-21 mm.

Occurrence—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 3870.

Collection.—Maryland Geological Survey.

Genus PALÆANATINA Hall

PALÆANATINA ANGUSTA Hall

Plate LIX, Figs. 16, 17

Palœantina angusta **Hall, 1885, Pal. of N. Y., vol. v, pt. 1, ii, p. 490, pl. lxxix, figs. 29-34.**

Description.—" Shell small, elongate, narrowly elliptical or subcylindrical; length from two and a half to three times the height; basal margin straight or slightly sinuate. Posterior extremity obliquely truncate or regularly rounded. Cardinal line straight or slightly declining posteriorly. Anterior end narrow, rounded. Left valve gibbous in the umbonal region. Right valve less gibbous and more depressed below the umbonal ridge. Beaks between the anterior third and fourth, small, scarcely rising above the hinge. Umbonal slope obtusely subangular, extending to the postinferior extremity. Postcardinal slope flat or con-

cave, with a fold in the left valve, a feature not observed in the right valve. There is a shallow undefined depression extending from the umbo to the base, scarcely affecting the margin. Surface marked by fine concentric striæ, which becomes fasciculate on the posterior end of the shell." Hall, 1885.

The specimens, while poorly preserved, have the characteristics of the New York species with sufficient distinctness to render their identification very probably correct. The species has been observed only in the upper ferruginous beds of the Chemung.

Length 21-32 mm.; height 9-10 mm.

Occurrence—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 4596 abundant; 2 miles west of Pawpaw, West Virginia, 4694.

Collection.—Maryland Geological Survey.

Genus SPHENOTUS Hall

SPHENOTUS CONTRACTUS Hall

Plate LIX, Figs. 18, 19

Cypricardia contracta **Hall, 1843, Geol. of N. Y., Rept. on the 4th Dist., p. 292, pl. cxxxix, fig. 4.**

Sphenotus contractus **Hall, 1885, Pal. of N. Y., vol. v, pt. i, p. 399, pl. lxvi, figs. 1, 3-9, 11-13, 15; pl. xciv, fig. 2.**

Description.—Shell elongate-trapezoidal, wider behind; length more than twice the height; basal margin nearly straight, faintly constricted in the middle. Posterior extremity oblique, rendered somewhat doubly truncate by the ridge on the posterior slope. Cardinal line straight, long, nearly parallel to the basal margin. Anterior end short, abruptly declining from the beak and narrowly rounded below. Valves equally convex. Umbonal slope angular and extending to the postlateral extremity. Surface with fine concentric striæ.

Length 35 mm.; height 13 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. On National Road, 1 mile west of Sideling Creek; near top of Green Ridge; 1½ miles west of Corriganville and near contact with Hampshire formation 1 mile east of Barrelville. Northeast edge of Deer Park.

Collection.—Maryland Geological Survey.

Family PRAECARDIIDAE

Genus BUCHIOLA Barrande

This name was introduced for shells which had been passing current in European literature as *Venericardium retrostriatum* von Buch and *Cardium palmatum* Goldfuss. Professor James Hall had at an early date described a species of the same general type as these under the name *Avicula speciosa* and afterwards (in 1885) introduced the generic name *Glyptocardia* for this particular species, a term which was too late for recognition, as Barrande's name already occupied the field. These small shells all agree in the general expression of their exterior which is, in a characteristic example of the genus, quite strongly ribbed, the ribs bearing sharp recurved and often chevron-shaped concentric ridges. Uniformity in the character of the exterior has led to the assembling, up to within recent years, of all forms known under one or another of the specific terms above mentioned, but a more careful analysis of the species undertaken by Beushausen has shown the existence, in the stages of the German Devonian, of a very considerable number of well-defined specific types. Similarly a careful restudy of the shells which have been known in New York as *Avicula* or *Cardiola,* or finally *Glyptocardia speciosa* Hall, which had been assigned a range from the Marcellus shales to and into the Portage stage, shows that here again a number of distinct, specific types have been brought under one term. The senior author has had occasion to work out in some detail the nature, persistence and local value of the various types of *Buchiola* in the Naples fauna of western New York and the facts there acquired are supplemented in a very interesting manner by the manifestations of this genus in the same fauna in its Maryland representation.

The shells of *Buchiola* were small, diaphanous, fragile bodies appertaining to the group which Neumayr termed the Palæoconchæ and which Beushausen proposed to change on account of their not being essentially early types, to the form Cardioconchæ. In these shells the hinge is long and straight, and bears a narrow linear ligamental area. Preparations of delicate replacements of the shell in barium sulfate, acquired from the

limestone nodules of the Naples beds in Ontario County, New York, show that the hinge may bear on its edge a row of minute denticulations which is in accordance with the determination made by Neumayr, but it seems quite unlikely that these denticulations are homologous with true hinge teeth, save in so far as they assist the articulation of the valves and it is certain that they are not always present. In the stronger expressions of this type of structure there is no difficulty in associating germane members of this genus, but it is to be observed that the genus passes by very easy gradation into that group which has been characterized by the term *Paracardium* Barrande. We find the latter shells recognizable by greater numerical development of the ribs, the lack of the characteristic concentric ornament upon these ribs, and the general extinction of the characteristics of *Buchiola;* not that there is any fundamental difference in the structure of the two groups, but both are of the same diaphanous, fragile character peculiar to the palæoconchs, and in respect to hinge structure both seem to be alike. There are species however upon which each genus seems to have a distinctive claim. With the multiplication of the number of ribs the ornamentation of the surface becomes progressively obscured, and while the latter may become quite extinct there are forms in which the two features are combined and which, hence, appertain as fairly to one of these divisions as the other. *Paracardium doris* Hall, which we find abundant in the New York and Maryland development of the Naples fauna is an excellent representation of the fully developed Paracardium type.

In New York the genus *Buchiola* reaches, as before observed, from the early middle Devonican into the lower upper Devonian. It is in the latter, the Naples fauna or the zone of *Manticoceras intumescens,* where the genus attains its culminant development, and it is at this horizon also that throughout the paleozoic faunas of the world the genus attains its maximum. In Maryland the genus has not yet been recorded from horizons other than those of the Naples fauna, while in the now thoroughly well-known range of the genus in Germany it has very much the same extent as in America, with its maximum in the lower upper Devonian, species passing even higher into the stages of the upper Devonian.

BUCHIOLA RETROSTRIATA (v. Buch)[1]

Plate LX, Figs. 1-3

Description.—The specific name of this shell entered into literature as long ago as 1832 when von Buch used the name *Venericardium retrostriatum* for shells from the upper Devonian of Büdesheim. With whatever generic name this specific term or the term *palmatum* employed by Goldfuss has since then been combined, whether *Avicula, Cardiola, Glyptocardia* or *Buchiola,* the expression was in effect a generic one until the date of Beushausen's careful analysis of the German species of *Buchiola* and the differentiation of the typical *B. retrostriata.* The American species of the genus, derived from the Devonian and in the main from the characteristic horizon at the base of the upper Devonian (*Intumescens zone*) have had a similar history. The name *Avicula speciosa* was first applied to them by Hall in 1843 and he subsequently introduced the generic term *Glyptocardia* for the species though too late for recognition, as Barrande's *Buchiola* was already in the field. The identity of the New York and European shells was recorded in 1891 by the writer who has since that date been enabled to determine in part, at least, the substantial local variations of the American shells which have heretofore been concealed under v. Buch's name.

Buchiola retrostriata, the original and typical species, is distinguished from other species of the genus by the following combination of characters. It bears 12-15 ribs which have elevated margins, more or less depressed, and flat summits which are crossed by pretty strong retrally curved or often chevron-shaped ridges, not traversing the line-like margins, and often varying in strength in different parts of the shell. The condition exhibited in one of our figures which is that of an old shell is quite characteristic of the species, showing the variation in the strength of these concentric markings, subdued in early age, strongest at maturity and again declining in strength about the margins of the old shell. The furrows between the ribs are narrow, flat and always smooth. These

[1] For synonymy see Clarke, Naples Fauna in Western New York; N. Y. State Mus., Mem. vi, p. 292, 1904; for figures, *idem*, pl. x, figs. 1-14.

features seem to persist and to exclude danger of confounding the species with its many associates in the Naples fauna of both Maryland and New York.

Buchiola retrostriata is not known to occur in American strata older than the Portage or Naples fauna. The genus does indeed occur in the shales of the Marcellus and Hamilton stages in New York and has been reported as *Glytocardia speciosa,* but these shells are altogether distinct from *B. retrostriata.*

In New York the species occurs first in the Styliola limestone (Genesee stage), which embodies the initial appearance of the Naples fauna and is extremely abundant throughout the manifestations of this fauna in the Naples (Portage) beds of region between the Cayuga Lake and Genesee valleys in the Naples subprovince. In the more eastward extension of Portage rocks it is only occasionally seen where accompanying a tongue of Naples sediment penetrating into the central province, and in the westerly counties having outcrops of Portage rocks, Erie and Chautauqua (Chautauqua subprovince), it is quite rare.

In the broad and older use of the term the shell is very widely distributed on the horizon of the lowest upper Devonian in Britain, Germany, France, Belgium, Russia and Siberia, but in its more restricted application some of these records must be regarded as subject to modification. Yet, notwithstanding this consideration, it is the most generally diffused representative of the genus. In Westphalia and in the Hartz it occurs in both lower and upper stages of the upper Devonian.

Length 8 mm.; height 6 mm.

Occurrence.—JENNINGS FORMATION, GENESEE MEMBER. About 100 feet above junction of Flintstone and Town creeks; Gilpintown; Cumberland, Williams Road and McKay's Hill, southeast of city; Barrelville Road one-half mile west of Corriganville; National Road just west of Wolfe Mill; five and one-half miles southwest of Burlington, West Virginia, on the Romney Road. WOODMONT MEMBER, NAPLES FAUNA, Gilpintown east of bridge over Town Creek.

BUCHIOLA CONVERSA Clarke

Plate LX, Figs. 4-6

Buchiola conversa **Clarke, N. Y. State Mus., Mem. vi, p. 300, pl. x, fig. 22, 1904.**

Description.—This species is smaller than the average of *B. retrostriata* and has a more circular outline. While it has about the same number of ribs as that species, 12-15, these are extremely fine and though flat at the start become highly concave over the body of the shell by the elevation of the lateral margins into linear ridges. As the furrows between the ribs have about the same width the shell may present the appearance of bearing double the number of ribs ascribed to it, each rib assuming a duplicate appearance due to the depth of its surface depression. Only the faintest trace of concentric markings is to be discovered.

The peculiar surface characters render it quite easy of separation from its associates in the same genus, but we find that this style of ornament is approached by some of the forms assigned to the genus *Paracardium* (*e. g., P. duplicatum* Clarke, Naples fauna of New York) and serves to indicate the quite conventional value of the latter genus.

Length 6 mm.; height 5 mm.

The typical specimens of this species are from the lower beds of the Naples shales in New York north of Portageville in the Genesee Valley and a figure of the type specimen is here given.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, NAPLES FAUNA. Polish Mountain section on the National Road east of Gilpintown.

Collection.—Maryland Geological Survey.

BUCHIOLA MARIÆ n. sp.[1]

Plate LX, Figs. 7, 8

Description.—This species will be found to differ from other representatives of the genus in the following particulars: It has the size and form of *B. retrostriata* but carries fully 20 ribs, all sharply elevated

[1] See Clarke, N. Y. State Mus., Mem. vi, p. 212, 1904.

and flat, their upper surfaces bearing concentric, retrally curved but not angulated striæ, all of which are fine, small and of uniform size. The interspaces between the ribs also show such concentric striæ on the lateral slopes of the valves but these are very much finer than on the ribs, and over the median parts of the shell cannot be discerned. The distinction from *B. livoniæ,* described below is found in the prominence of the ribs and the distinct concentric ornamentation as well as somewhat also in the form of the shell.

Length 5 mm.; height 3 mm.

Occurrence.—JENNINGS FORMATION, GENESEE MEMBER. This form of *Buchiola* is not common having been found only in the shales on the Williams Road ½ mile east of the Queen City Hotel, Cumberland, and no precisely similar expression has yet been observed in the Intumescens fauna of New York or Europe.

Collection.—Maryland Geological Survey.

BUCHIOLA (?) LIVONIAE Clarke

Plate LX, Figs. 9-12

Buchiola livoniæ **Clarke, 1904, N. Y. State Mus., Mem. vi, p. 299, pl. xi, figs. 1, 2.**

Description.—Shell of rather large size and transversely ovate with the greatest vertical diameter posteriorly. It is specially distinguished by the character of its surface which is marked by about 20 very low flat ribs having nearly twice the width of the spaces between them. The sides of the ribs are erect though very low and so obscurely are they developed that sometimes it is difficult to trace them on the anterior slope of the valves. In every case, however, the first or three short ribs beneath the beak on the anterior moiety of the hinge are strong elevated and rounder than the rest. Extremely fine concentric lines cover both ribs and furrows but this ornamentation can only be seen by favorable illumination.

Length 7 mm.; height 5 mm.

Buchiola livoniæ was first found in the Styliola limestone (Genesee shale) of the great salt shaft put down at Livonia, New York, and it

appears to have been a rather rare form in the Naples fauna of that region. In Maryland, however, it is much more generally diffused.

The typical form of the species from the Styliola limestone of New York is here figured for comparison with the Maryland specimens.

Occurrence.—JENNINGS FORMATION, GENESEE MEMBER. Romney Road 3½ miles southwest of Burlington, West Virginia; Wolfe Mill on National Road, 3 miles northeast of Cumberland; hill on Williams Road near Cumberland. WOODMONT MEMBER, NAPLES FAUNA. Gilpintown on National Road about 80 feet east of Town Creek.

Collection.—Maryland Geological Survey.

Genus PARACARDIUM Barrande

Under this term have been placed certain paleoconchs which, as has been observed above, are similar to *Buchiola* in all particulars except the general expression of the surface. The latter is many-ribbed and in its typical expression as shown in *P. doris,* these ribs lack the chevroned character of *Buchiola.* Yet in some species there is an evident though fine concentric ornament on ribs and furrows alike. The hinge structure is identical with that of *Buchiola* showing a linear ligament groove and sometimes a single row of fine denticulations on the hinge margin. While the validity of the genus *Paracardium* may be regarded as open to question, it forms at the present a convenience in the nomenclature of these shells.

PARACARDIUM DORIS Hall

Plate LX, Figs. 13-16

Cardiola doris **Hall, 1783, Pal. of N. Y., vol. v, pt. i, plates and explanations 70, figs. 10, 11.**
Paracardium doris **Hall, 1885, *Ibid.*, p. 428.**
Paracardium doris **Clarke, 1904, N. Y. State Mus., Mem. vi, p. 304, pl. xi, figs. 5-10.**

Description.—These shells are small, averaging about the same size as specimens of *Buchiola* but are quite regularly ovate with the greatest vertical diameter posteriorly. There are from 20-25 simple rounded ribs running from beak to margin, separated by furrows of the same

width as the ribs themselves. The shell normally assumes the circular form and curved ribs represented by Hall's figures, but this outline is seldom retained in the shales, though always shown in the barite replacements occurring in the lime nodules of the New York strata.

In New York the species is very abundant in the Styliola limestone (Genesee) and in the olive Naples shales throughout the region between the Genesee River and Cayuga Lake and is occasionally seen in the lower eastward horizons. West of the Genesee River, in the Chautauqua subprovince, it is seldom seen.

Paracardium doris is quite generally diffused throughout the Genesee member and the beds containing the Naples fauna in the Woodmont member.

Length 7 mm.; height 5 mm.

Occurrence.—JENNINGS FORMATION, GENESEE MEMBER. On the hill directly southeast of Cumberland; west of Corriganville on the Barrelville Road; just west of Wolfe Mill; and on the Parker farm near Burlington, West Virginia. WOODMONT MEMBER, NAPLES FAUNA. National Road east of Gilpintown.

Collections.—Maryland Geological Survey, New York State Museum.

PARACARDIUM DELICATULUM Clarke

Plate LX, Figs. 17, 18

***Paracardium delicatulum* Clarke, 1904, N. Y. State Mus., Mem. vi, p. 304, pl. xi, fig. 4.**

Description.—To this species, which has already been observed in the Styliola limestone on Canandaigua Lake, New York, is referred a small shell with hair-lined surface and subcircular outline. A drawing of the New York form is introduced here for purposes of comparison. The surface of the shell bears from 50-70 very fine simple riblets, this character in itself serving as the distinguishing feature of the species.

Length 5 mm.; height 3 mm.

Occurrence.—JENNINGS FORMATION, GENESEE MEMBER. On the National Road just west of Wolfe Mill, near Cumberland.

Collection.—Maryland Geological Survey.

Superfamily NUCULACEA

Family NUCULIDAE

Genus NUCULA Lamarck

NUCULA CORBULIFORMIS Hall

Plate LX, Figs. 19-23

Nucula corbuliformis Hall, 1870, Preliminary Notice Lamellibranchiata, ii, p. 2.

Nucula corbuliformis Hall, 1885, Pal. of N. Y., vol. v, pt. i, p. 319, pl. xlvi, figs. 24-34.

Nucula corbuliformis Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 396, fig. 503.

Description.—Shell small, triangular; beak prominent acute and anterior, umbonal slopes direct. Length and height sometimes nearly equal, anterior margin broadly rounded. Hinge-line sloping and bearing denticulations on both sides of the beak. Surface convex, depressed in the umbonal region; covered by fine but not conspicuous concentric striæ.

Length 9 mm.; height 6 mm.

Nucula corbuliformis is common in the Hamilton shales and occasionally occurs in the Ithaca fauna of New York.

It is of rare occurrence in the Chemung, occasional in the Parkhead, and locally abundant in the Ithaca fauna of Maryland.

A single specimen was found in the Ithaca fauna at Hancock which is unusually gibbous and has very deep muscular scars. It is probably a gerontic individual of this species.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Oakland-Altamont Road; Town Creek, 2228. PARKHEAD MEMBER. Williams Road, on Polish Mountain, 1352; 2 miles north of mouth of Town Creek, 1716 abundant, 1803. WOODMONT MEMBER, ITHACA FAUNA. National Road west of Tonoloway Ridge in soft yellow argillaceous sandstone; Hancock, 1149 to 1274; Yellow Springs, West Virginia.

Collection.—Maryland Geological Survey.

Genus NUCULITES Conrad

NUCULITES sp. ?

Description.—The presence of this genus in the Jennings of Maryland is indicated by a single specimen too incomplete for identification yet showing the hinge teeth and the anterior vertical interior ridge or clavicle behind the forward muscular scar.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. West slope of Polish Mountain; Allegany County.

Collection.—Maryland Geological Survey.

Family LEDIDAE

Genus PALÆONEILO Hall

PALÆONEILO CONSTRICTA (Conrad)

Plate LXI, Figs. 7-10

Nuculites constricta Conrad, 1842, Jour. Acad. Nat. Sciences, Phila., vol. viii, p. 249, pl. xv, fig. 8.
Palæoneilo constricta Hall, 1885, Pal. of N. Y., vol. v, pt. i, p. 333, pl. xlviii, figs. 1-16, pl. li, fig. 17.
Palæoneilo constricta Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 400, figs. 510*a*, *b*.
Palæoneilo constricta Cleland, 1911, Bull. xxi, Geol. Survey Wis., p. 102, pl. xx, figs. 9, 19-22.

Description.—Shell of rather small size, ovate-cuneate, subnasute behind. Basal margin rounded in the middle and anterior portions, straight or slightly constricted toward the posterior end. Posterior end narrow and constricted below. Valves equally convex. Beaks at anterior third. Umbonal ridge rounded with a depression or undefined furrow below it extending from just behind the beak to the postinferior margin.

Surface with fine, concentric, thread-like lines. Hinge with numerous denticulations and sockets characteristic of the genus.

Length 20 mm.; height 14 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Northeast of Deer Park; National Road on top of Green Ridge. WOODMONT MEMBER, ITHACA FAUNA. Woodmont, 710.

Collection.—Maryland Geological Survey.

PALÆONEILO PLANA Hall

Plate LXI, Figs. 1-3

Palæoneilo plana Hall, 1870, Prelim. Notice Lammellibr., vol. ii, p. 7.
Palæoneilo plana Hall, 1885, Pal. of N. Y., vol. v, pt. i, sec. ii, p. 334, pl. xlviii, figs. 21-28.
Palæoneilo plana Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 399, fig. 510.
Palæoneilo plana Cleland, 1911, Bull. xxi, Geol. Survey Wis., p. 104, pl. xx, figs. 15-16.

Description.—Shell below medium size, elongate-ovate, length about twice height, occasionally greater. Cardinal margin curved, slightly concave anterior to umbo, slightly convex posterior to umbo; ventral margin gently curved; anterior extremity rounded; becoming narrower towards posterior extremity which is abruptly rounded. Valves convex, somewhat gibbous towards umbo; cast of interior slightly concave in some specimens towards posterior extremity. Beak small, not much elevated above hinge-line, situated about one-third length from anterior extremity. Umbonal slope rounded, not distinct. Casts of interior show hinge teeth in a curved line, teeth at extremities being stronger; anterior and posterior muscular scars shallow; anterior scar separated from umbo by a slight ridge in some shells. Surface with faint concentric lines. Test thin.

Length 18 mm., occasionally more; height 9 mm.

The individuals referred to this species differ in some respects from those described by Hall. They are, however, probably the same species although this identification is not without question. A specimen from near Pratt is much more elongate than usual. This species closely resembles *P. elongata* of the Chemung of New York. It differs in being larger with beak nearer anterior extremity. It differs from *P. crassa* in being smaller, more elongate, test thin, muscular scars shallow.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road west of Frostburg; Town Creek, 2228, 2391, 3969; 2 miles west of Pawpaw, 2124; 2¼ miles northeast of Pratt near home of Mr. Cheney ?; Millstone, 2322 abundant. PARKHEAD MEMBER. Town Creek, 1679 ?, 1851. WOODMONT MEMBER, ITHACA FAUNA. Little Orleans, 1446.

Collection.—Maryland Geological Survey.

PALÆONEILO MAXIMA (Conrad)[1]

Plate LX, Fig. 25

A few specimens have been observed which are not well enough preserved to permit confident identification. They are probably of this species.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Two miles north of mouth of Town Creek, 1282, 1312.

Collection.—Maryland Geological Survey.

PALÆONEILO BREVIS Hall

Plate LXI, Figs. 4-6

Palæoneilo brevis Hall, 1870, Prelim. Notice Lammellibr., pt. ii, p. 10.

Palæoneilo brevis Hall, 1885, Pal. of N. Y., vol. v, pt. i. sec. ii, p. 342, pl. 1, figs. 24-33.

Palæoneilo brevis Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 400, fig. 510.

Palæoneilo brevis Cleland, 1911, Bull. xxi, Geol. Survey Wis., p. 101, pl. xx, figs. 6-7.

Description.—" Shell small, ovate, or ovate-subtriangular; length about one-third greater than the height; basal margin gently curving, with a slight constriction toward the posterior extremity. Cardinal line arcuate. Anterior end usually short and regularly rounded. Valves convex below, gibbous in the middle and on the umbonal ridge. Beaks usually at about the anterior third or a little posterior thereto, prominent, moderately elevated above the hinge-line. Umbonal slope marked by a slight flattening of the shell, which produced a gentle constriction in the postinferior margin. This depression is rarely margined on each side by an undefined elevation. Surface marked by fine, even, concentric striæ; the casts exhibiting only the stronger elevations which give an irregular appearance to the concentric striæ. Anterior muscular impression very strongly marked. Posterior scar large and shallow. Hinge marked by numerous minute crenulations. Three specimens of this species measure respectively 21, 20, and 14 mm. in length, and 14, 12, and 10 mm. in height. This species is allied to *P. constricta,* but is more gibbous,

[1] For synonymy and description see page 238.

less curved along the basal margin, and the constriction of the posterior end is so slight as to be scarcely detected in most individuals." Hall, 1885.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. National Road, on Polish Mountain, 1196 ?; 2 miles west of Pawpaw, West Virginia, 1484, 1763 common. WOODMONT MEMBER, ITHACA FAUNA. Two miles west of Pawpaw, West Virginia, 1388; Little Orleans 1446; Woodmont 1032, 1067 cf.; Hancock, 1149 to 1274; Berkeley Springs, West Virginia, 1674 cf.; Yellow Springs, West Virginia.

Collection.—Maryland Geological Survey.

PALÆONEILO FILOSA (Conrad)

Plate LXI, Figs. 11, 12

Nuculites filosa **Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 250, pl. xv, fig. 7.**

Palæoneilo filosa **Hall, 1885, Pal. of N. Y., vol. v, pt. i, p. 343, pl. xlix, figs. 33-38.**

Description.—Shells small, transversely subelongate, length about twice the height; tapering posteriorly with a decided sinuosity on the posterior margin caused by the oblique groove between which and the hinge is a low ridge. Beaks at the anterior third of the transverse diameter. Surface with regular and sharp and elevated lamellose concentric striæ becoming more conspicuous on the posterior slope. Dimensions of the Maryland specimens, which are of smaller habit than the New York shells; length 9 mm., height 5 mm.

Notwithstanding the small proportions of these shells they agree with the typical form in all essential particulars. The New York shells occur in the Ithaca fauna of the central region of that State.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Near Deer Park; Tiger Valley about 1 mile west of Wills Creek Station, Pennsylvania; 2¼ miles northeast of Pratt near home of Mr. Cheney, near base of Chemung.

Collection.—Maryland Geological Survey.

PALÆONEILO ANGUSTA Hall

Plate LXI, Fig. 13

Palæoneilo angusta Hall, 1885, Pal. of N. Y., vol. v, pt. i, sec. ii, p. 344, pl. xciii, fig. 11.

Description.—Shell below medium size, elongate-elliptical, length more than twice height. Postumbonal part of cardinal margin straight, declining from umbo; anterior extremity rounded; ventral margin curving slightly, nearly straight in middle part; posterior extremity produced, doubly emarginate. Valves low, convex with a slight sulcus in front of umbonal slope. Umbo about one-third length from anterior end, low, closely appressed, rising but little above hinge-line. Umbonal slope slightly angular, postcardinal slope broad, divided longitudinally into two parts by a low angular fold which extends to posterior extremity. Surface bearing faint concentric striæ save on postcardinal slope where the striæ become stronger, thread-like and are about 1 mm. apart.

Length 17 mm.; height 7 mm.

A single valve has been observed. It differs from the typical form in being more elongate, surface smoother, lamellose lines on postcardinal slope more distant. It agrees, however, in its general features with the species to which it is referred. The surface ornamentation distinguishes this species from all other species of Palæoneilo in the fauna.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Oakland-Redhouse Road.

Collection.—Maryland Geological Survey.

PALÆONEILO PETILA Clarke

Plate LX, Fig. 24

Palæoneilo petila Clarke, 1904, Mem. N. Y. State Mus., No. vi, p. 311, pl. xv, figs. 1-8.

Description.—" This little shell in some features is similar to *P. constricta,* having a sinuous posterior extremity and the arrangement of the ligament pits as in that species. It is, however, always small, transversely ovate, never so broad as in *P. constricta;* beak behind the anterior third of the length, anterior margin subelliptic, basal margin convex, broadly

curved, often with an interruption to this curvature caused by the projection of the low umbonal ridge; narrowing behind to a subattenuate posterior extremity and emarginate by the posterior sinus. Postcardinal slope long and oblique. Surface convex on the umbones, sloping rather abruptly to the front margin; behind, the surface is sinused by a broad, low depression which brings into prominence a postmedian umbonal ridge. Specimens from the shales and the barite replacements indicate that the surface was smooth or with obscure concentric growth lines. This condition is clearly shown in most of our figures. Only one, an incomplete replacement, shows that over the posterior part of the shell the concentric lines are well defined and elevated, but not to such degree as in other species. On the interior, anterior and posterior part of the shell the concentric lines are well defined and elevated, but not to such degree as in other species. On the interior, anterior and posterior muscular scars, with thickened inner walls, are at times very sharply defined. The cardinal area is broadly arched, the denticulations are all vertical and decrease in size beneath the beak." Clarke, 1904.

Length 17 mm.; height 11 mm.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, NAPLES FAUNA. Williams Road, 3½ miles east of Cumberland.

Collection.—Maryland Geological Survey.

PALÆONEILO CRASSA n. sp.

Plate LXI, Figs. 14, 15

Description.—Shell of medium size, ovate, length about 1.6 height. Cardinal margin arcuate, declining posteriorly; ventral margin gently curved; anterior extremity regularly rounded; posterior extremity narrowly rounded. Valves convex, becoming decidedly gibbous near umbo in older individuals, surface sloping abruptly towards hinge-line, more gradually towards anterior end and ventral margin; very gradually towards posterior extremity near which the cast is occasionally concave. Beaks small, anterior, situated between one-fourth to one-third transverse diameter from anterior end, elevated slightly above hinge-line. Umbonal slope rounded, not defined.

The shell becomes thick and massive in older individuals. Surface smooth with faint concentric striæ. Cast of interior shows a broad hinge-plate bearing long teeth which are in one line, teeth coarse at extremities of hinge, fine beneath umbo. Anterior and posterior muscular scars deep; umbo bearing a number of umbonal pits; pallial line distinct.

Length of larger individuals 25 mm.; height 16 mm. or slightly greater in some cases; attaining a thickness of 14 mm.

This species is characterized by its thick test and the lack of a defined umbonal ridge and sulcus. In the latter respect it resembles *P. elongata* of the Chemung of New York but it is less elongate than that species.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road west of Frostburg; Town Creek, 3453 cf., 3538 common, 3584 abundant, 3593 common; west of Tonoloway Ridge near Pennsylvania-Maryland state line opposite school house.

Collection.—Maryland Geological Survey.

Genus LEDA Schumacher

LEDA cf. DIVERSA Hall

Plate LXI, Figs. 16, 17

Leda diversa Hall, 1885, Pal. of N. Y., vol. v, pt. i, sec. ii, p. 329, pl. lxvii, figs. 31-37.

Leda diversa Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 401, fig. 511.

Description.—Shell small, falciform; length twice or a little more than twice width. Cardinal margin convex, post-umbonal portion concave upwardly, anterior portion slightly convex, declining from beak; ventral margin gently curved; posterior end smaller than anterior end, attenuate, curved upwards. Valve convex. Umbo situated about one-third length from anterior end. Umbonal ridge extending from beak to posterior extremity; surface of shell sloping abruptly from it to hinge-line, rounding gently to ventral margin. Surface ornamentation unknown.

Length 10-12 mm.; height 3-5 mm.

The specimens figured differ considerably in form and may not all belong to the same species. Their proportions suggest *L. diversa* of the Ham-

ilton of New York but the concentric striæ which ornament the surface of that species have not been observed, as casts of interior only have been found in Maryland.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Allegany Grove, 1633; Town Creek, 3760, 3870. PARKHEAD MEMBER. Four miles southeast of Pratt on White Sulphur Branch.

Collection.—Maryland Geological Survey.

Superfamily ARCACEA

Family PARALLELODONTIDAE

Genus MACRODON Lycett

MACRODON CHEMUNGENSIS Hall

Plate LXI, Fig. 18

Macrodon chemungensis Hall, 1870, Prelim. Notice Lammellibr., pt. ii, p. 14.

Macrodon chemungensis Hall, 1885, Pal. of N. Y., vol. vi, pt. i, sec. ii, p. 350, pl. li, figs. 11-16.

Description.—" Shell of medium size or larger, arcæform; cardinal and basal margins subparallel; length more or less than twice the height; basal margin nearly straight or gently curving with a slight constriction anterior to the middle. Posterior end broad, subtruncate or sometimes rounded. Cardinal margin straight, extremities angular. Anterior end rounded below, truncate above. Valves convex in the posterior portion, becoming gibbous in the middle and anterior. Beaks subanterior, prominent, rising a little above the hinge-line. Umbonal region gibbous, with a prominent, undefined ridge extending toward the postinferior extremity, and a vertical depression extending from the umbo to the base. Surface marked by irregular, concentric, lamellose lines of growth. Three specimens measure respectively 31, 27, and 22 mm. in length, and 14, 15, and 10 mm. in height. This species is distinguished by its parallel basal and cardinal margins, the truncated posterior end and its narrow form." Hall, 1885.

A single valve has been observed which seems clearly referable to the species.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Four miles southeast of Pratt on White Sulphur Branch.

Collection.—Maryland Geological Survey.

Superfamily PTERIACEA

Family PTERINEIDAE

Genus PTERINEA Goldfuss

PTERINEA NODOCOSTA n. sp.

Plate LXI, Figs. 19-21

Description.—Shell of medium to large size, suberect, scarcely oblique. Body broad, subtransverse in front. Anterior wing small; posterior wing broad and acute but not greatly extended. Surface with 4-5 very strong radii, nodose at distant intervals. Between these radii lie others of various or alternating size, 3-5 in each interval over the shell body. On the posterior wing the radii are obscure and subequal; the anterior wing is also plicate. Strong concentric striæ cover the marginal parts of the shell. Of an average individual, height and hinge-length 62 mm.; width across the body 55 mm.

Prof. Hall figured in Paleontology of New York (vol. v, pt. i, pl. lxxxiii, fig. 11) a large shell from the Chemung beds which he referred to *Pterinea flabella* Hall of the Hamilton fauna but which has characters very similar to those here described. The size, suberect form and the nodate or subnodate character of the princapal radii are features in which this later shell differs from *P. flabella.* The single example showing the exterior given by Hall does not indeed represent the major ribs as distinctly nodate but the specimen has been corroded by exposure and in its original condition was probably similar in structure to that here described.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Oakland-Altamont Road; R. Gordon's farm 1 mile northeast of Mountain Lake Park; northeast edge of Deer Park; 2 miles south of Oakland.

Collection.—Maryland Geological Survey.

PTERINEA CHEMUNGENSIS (Conrad)

Plate LXI, Fig. 22

Avicula chemungensis **Conrad, 1842, Journ. Phila. Acad., vol. viii, p. 243.**
Pterinea chemungensis **Hall, 1884, Pal. of N. Y., vol. v, pt. i, p. 98, pl. xvi, figs. 3, 7, 10, pl. lxxxiv, fig. 21.**
Pterinea chemungensis **Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 421, fig. 552.**

Description.—Shell large, obliquely subovate in outline; length less than height, greatest length below the middle. Left valve moderately convex, right valve depressed. Hinge-line straight, nearly equalling the length of the shell. Beak anterior; anterior wing short, nearly equilateral, well set off from body of shell; posterior wing large subtriangular. Surface of left valve marked by slender subequal or alternating rays continuing over the posterior wing; interspaces flat. These are crossed by concentric striæ or interrupted by growth varices.

Length 60 mm.; height 50 mm.

This is a very characteristic member of the Chemung fauna in New York.

Williams cites this as one of the dominant species of the Chemung of New York. While abundant in the Chemung of Maryland it is not confined to that fauna, but occurs, though rarely, both in the Parkhead and Ithaca.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Oakland-Altamont Road; National Road west of Frostburg; Ellerslie, Pennsylvania, 1316, 1474 abundant, 1508 abundant; Williams Road, on Polish Mountain, 2042; National Road, on Polish Mountain, 2706, 2929; Pennsylvania state line, west of Green Ridge, upper *Tropidoleptus zone;* Town Creek, 2228; Fifteenmile Creek, 1 mile above Little Orleans, 2215 ?; 2¼ miles northeast of Pratt near home of Mr. Cheney. PARKHEAD MEMBER. Allegany Grove, 850. WOODMONT MEMBER, ITHACA FAUNA. Little Orleans, 1446; Fifteenmile Creek, 1 mile above Little Orleans, 1446.

Collection.—Maryland Geological Survey.

Family LUNULICARDIIDAE

Genus LUNULICARDIUM Münster

There has been a recent effort to restrict the application of this term very narrowly and this has given opportunity for the erection of a considerable number of additional generic terms for shells commonly passing as *Lunulicardium*. The authors after a careful analysis of an extensive series of these shells have failed to find a satisfactory basis for either the restriction of the genus or the renaming of its species. *Lunulicardium* has subtriangular shells with a long and arched hiatus between the valves on the posterior slope. This opening is bounded by narrow smooth areas (sicæ) which may be either erect or projacent and which start at the umbo from the outer margin of the primitive shell. Behind the beaks is a short triangular cardinal area. The surface may be radially plicated, striated or smooth.

These shells are very abundant in the Naples fauna of New York especially in the Naples subprovince. In Maryland only the following two small species have been observed.

LUNULICARDIUM ENCRINITUM Clarke

Plate LXII, Figs. 1-3

Lunulicardium encrinitum **Clarke, 1904, N. Y. State Mus., Mem. vi, p. 239, pl. ii, fig. 20.**

Description.—Shell small subtriangular, umbo acute, lateral margins diverging rapidly and anterior margin forming a broad curve, not greatly truncating the anterior moiety of the commissure, its length equalling about two-thirds of the length of the shell. Sicæ smooth and nearly erect. Body of the shell generally convex, and covered with very fine simple radial striæ which number 100-125. Extremely fine concentric striæ are observable with favorable preservation.

Length 7 mm.; height 7 mm.

This species in New York has been recorded only from the village of Naples and it is on the specimens from this locality that the species is founded.

Occurrence.—JENNINGS FORMATION, GENESEE MEMBER. Near Wolfe Mill, Gilpintown.

Collection.—Maryland Geological Survey.

LUNULICARDIUM CYMBULA sp. nov.[1]

Plate LXII, Fig. 4

Description.—This species is distinguished by its transverse form and central umbo, the latter feature making the hiatus of about the same length as that of the hinge-line on the other side of the beak. In this respect the shell presents a quite unusual aspect, not indeed otherwise noted among these species. The transverse diameter of the shell is 1½ times its length. The surface is very finely lined as in *P. encrinitum* though the number of riblets is not so great.

Length 5 mm.; height 3 mm.

Occurrence.—JENNINGS FORMATION, GENESEE MEMBER. Near Corriganville where it is associated with *Paracardium doris, Tornoceras uniangulare, Pterochænia fragilis,* etc.

Collection.—Maryland Geological Survey.

Genus PTEROCHAENIA Clarke

Pterochænia is distinguished from *Lunulicardium* by the fact that the hiatus is anterior and the sicæ are in their normal condition extended outward and upward in the form of long narrow wings. These aliform sicæ are broad and convex near the beaks, narrowing rapidly downward; they are separated from the body of the valve by a deep and narrow double groove extending to the apex and enclosing a low ridge. In *Lunulicardium* the sicæ are normally vertical and much thickened; in *Pterochænia* they are always thin and their surface lines are continued directly from those on the body of the shell. Beneath the beak there is no triangular striated area as in the genera referred to and no ligamental striæ or articular processes are discernible. The surface of the valves is smooth; when well retained only concentric striæ are apparent but slight

[1] See N. Y. State Mus., Mem. vi, 1904, p. 212.

exfoliation frequently shows evidence of fine radial lines on the inner shell layer.

The type is *Avicula fragilis* Hall.

PTEROCHÆNIA FRAGILIS (Hall)

Plate LXII, Figs. 5-7

Avicula fragilis **Hall, 1843, Geol. of N. Y., Rept. 4th Dist., p. 222, fig. 94 (1, 2).**
Lunulicardium fragile **Hall, 1870, Preliminary Notice Lamellibr., pt. ii, p. 97.**
Lunulicardium fragile **Hall, 1885, Pal. of N. Y., vol. v, pt. i, p. 434, pl. lxxi, figs. 1-14.**
Lunulicardium fragile **Clarke, 1885, Bull. U. S. Geol. Survey, No. 16, p. 62.**
Lunulicardium fragile **Williams, 1887, Bull. U. S. Geol. Survey, No. 4, p. 38, pl. iii, fig. 7.**
Pterochænia fragilis **Clarke, 1904, N. Y. State Mus., Mem. vi, p. 249, pl. v, figs. 1-10.**

Description.—Shell small, somewhat obovate, often subcircular. Obliquely truncate in front, the margins gaping and bounded by thin expansions. Valves moderately convex with rather abrupt posterior slope. Beaks attenuate, erect or progyre. Surface with fine concentric striæ, radial striæ only in internal laminæ.

This peculiar and widely distributed species, the only described representative of its generic type of structure has already been pretty fully made known in the works above cited. It has an unusual vertical range without wide variation of the specific type, occurring first in the bituminous shales of the Marcellus stage, occasionally in the more calcareous beds of the Hamilton and again in the dark shales of the Genesee. In the Styliola limestone of the latter divisions it is profusely abundant while in the argillaceous beds carrying the Naples fauna it is one of the less common species of pelecypods. It is known also to have entered the Chemung fauna of western New York, a survivor of the migration of the Naples fauna from that region. Notwithstanding its extensive vertical range in the Devonian strata of western New York the species is not abundant west of the Naples subprovince of Portage time. In Maryland the species seems to be quite widely diffused.

Length 6 mm.; height 7 mm.

Occurrence.—JENNINGS FORMATION, GENESEE MEMBER. berland; Wolfe Mill; Corriganville; Parker farm near Burli Virginia. WOODMONT MEMBER, NAPLES FAUNA. National I Mountain, east of Gilpin; National Road west of Tonolowa

Collection.—Maryland Geological Survey.

Genus ECTENODESMA Hall

ECTENODESMA BIROSTRATUM Hall

Plate LXII, Figs, 8, 9

Ectenodesma birostratum Hall, 1884, Pal. of N. Y., vol. v, pt. 1, pl. xxiii, figs. 27-30; pl. lxxxiv, fig. 20.

Description.—"Shell large; body ovate, oblique; height g the length; margin regularly curving from the base of the an to the postbasal margin, where it is somewhat abruptly recu valve regularly convex below, gibbous in the umbonal region arcuate, the point of greatest convexity being about the mi length. Right valve concave below, depressed-convex in t convex on the umbo. Hinge-line straight, much longer than th the shell, and, in extreme specimens, more than once and a h than the length of the shell. Beaks acute, anterior to the the shell, inclined forward, and arching over the hinge-line. region gibbous, limited on the anterior side by a shallow, undefi and on the posterior side by the abrupt depression of the body, an acute angle. Anterior wing large, triangular; margir extremity produced to an acuminate extension. Byssal sin and undefined. Posterior wing large, triangular, joining the l the middle of its height; margin concave; extremity produce acute termination. Test of left valve marked with regular radii which are rounded above, flattened and sometimes bifurc similar but more acute radii continue over the posterior win right valve the rays are more numerous, finer and sharp, an tinued upon the posterior wing with a little less force than o of the shell; and very much subdued upon the anterior wing; face marked by fine, even, concentric striæ of growth. The

show an oblique lateral tooth, with obscure indications of anterior teeth or folds. Ligamental area narrow, marked with fine parallel striæ. A left valve has a length of 45 mm.; height 50 mm.; hinge-line, when entire, about 75 mm. A small right valve has a length of 34 mm., height 27 mm., hinge-line about 45 mm. This species is distinguished by the great and nearly equal extent of the hinge-line on both sides of the beak; by the peculiar form of the body of the shell; and by its surface characters, which are unlike any yet observed." Hall, 1884.

This species is characterized by its greatly elongated, acute, cardinal angles. It is an abundant and characteristic species of the Ithaca fauna of Maryland.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Two miles west of Pawpaw, West Virginia, 1340, 1388; Little Orleans, 1446; Fifteenmile Creek, 1 mile above Little Orleans, 1446; Woodmont 1032; Yellow Springs, West Virginia.

Collection.—Maryland Geological Survey.

Genus LIOPTERIA Hall

LIOPTERIA BIGSBYI Hall

Plate LXII, Figs. 10, 11

Liopteria bigsbyi **Hall, 1884, Pal. of N. Y., vol. v, pt. i, p. 165, pl. xx, figs. 3, 11, 13-15; pl. lxxxviii, fig. 23.**

Description.—Shell moderately large, suberect, broadly ovate body. Height greater than length. Anterior margin nearly vertical for about half the height of the shell, thence regularly rounded along the base. Both valves convex on the umbo, the right valve becoming depressed over the body. Hinge-line straight and less than the length of the shell. Beaks anterior, ear short, wing triangular and flat. Surface with lamellose concentric striæ.

Length 30 mm.; height 30 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 2023. PARKHEAD MEMBER. Two and one-quarter miles southeast of Cumberland ?; Williams Road, $3\frac{1}{2}$ miles east of Cumberland, 1466; Williams Road, on Polish Mountain, 1289 ?, 1660; National Road,

on Polish Mountain, 1196 ?; 2 miles north of m :
1312 ?, 1642 ?, 1842 ?; 2 miles west of Pawpaw, (
2½ miles above mouth of Sideling Hill Creek ?; N :
Tonoloway Ridge.

Collection.—Maryland Geological Survey.

LIOPTERIA cf. BIGSBYI Hall

Plate LXII, Fig. 12.

Description.—A large individual, compared wit
from Hall's figure of that species in several respects.
attenuate, not appearing to be extended beyond hi
not so sharply defined from umbo by a sulcus.

Occurrence.—JENNINGS FORMATION, CHEMUNG
Road, on Polish Mountain, 2714.

Collection.—Maryland Geological Survey.

LIOPTERIA MARYLANDICA n. sp.

Plate LXII, Figs. 13, 14

Description.—Shell subrhomboidal, body modera
ovate; length a little greater than width. Margir
ventrally, slightly extended posteriorly, valves mode
slightly concave near anterior and posterior margin.
umbo acute, arching over hinge. Ear short, rounded,
Wing large, triangular, not sharply defined from body
its extremity not observed. Cast of interior of le
slightly oblique folds upon hinge, posterior to umb

Length, 45 mm.; height 40 mm.

The left valve only has been observed. This spec
L. greeni. It differs chiefly in its slightly concav
convex body. It may be a variety of that species.

Occurrence.—JENNINGS FORMATION, CHEMUNG
Creek, 2023.

Collection.—Maryland Geological Survey.

LIOPTERIA AURICULATA n. sp.

Plate LXIII, Fig. 1

Description.—Shell small, very convex, body ovate, quite oblique; height two-thirds length. Margin curving regularly from below middle of anterior side to about middle of posterior side. Hinge-line long, straight, ear large for this genus, limited by a broad sulcus near margin. Cardinal margin of ear straight, continuous with hinge-line. Wing triangular, bounded by a broad sulcus, its margin concave, posterior angle acute, produced. Surface marked by fine concentric striæ.

Length 20 mm.; height 11 mm.

A single left valve only has been observed. This specimen is characterized by its large ear, the cardinal edge of which is in same line with hinge-line. It resembles *L. gabbi* in this respect but its body is much more oblique. The reference of this species to the genus *Liopteria* is not assured, the ear being so large as to place it near the genus *Leptodesma*.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Millstone 795.

Collection.—Maryland Geological Survey.

Genus LEPTODESMA Hall

LEPTODESMA ROGERSI Hall

Plate LXIII, Fig. 3

Leptodesma rogersi Hall, 1884, Pal. of N. Y., vol. v, pt. 1, p. 176, pl. xxi, figs. 1-9.

Leptodesma rogersi Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 426, fig. 556.

Description.—Shell usually of small size, body ovate, very oblique, length greater than height; anterior and basal margins broadly rounded, posterior margin extended and abruptly recurved. Valves subequally convex above. Right valve somewhat depressed below, comparatively higher than the left. Hinge-line longer than the length of the shell. Surface with fine concentric striæ.

Length 25 mm.; height 15 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Two miles south of Oakland, Garrett County.

Collection.—Maryland Geological Survey.

LEPTODESMA LONGISPINUM Hall

Plate LXIII, Figs. 4-8

Avicula longispina **Hall, 1843, Geol. Surv. N. Y., 4th Dist., p. 262, fig. 3.**
Leptodesma longispinum **Hall, 1884, Pal. of N. Y., vol. v, pt. 1, p. 179, pl. xxi, figs. 14, 17-19, pl. lxxxix, figs. 2-4.**

Description.—Shell rather small, elongate subrhomboidal, body elongate, obliquely ovate, length greater than height; margin from byssal sinus to beyond the base broadly rounded, posterior margin regularly recurved. Posterior wing prominent, depressed on right valve and on both produced into a long narrow spine. Surface convex on both valves broadly depressed by the anterior oblique sinus, this depression distinguishing the species from forms like *L. lichas* having similar proportions but with a broader anterior ventral slope. Fine regular concentric lines over all the surface.

Dimensions of an average specimen; length from anterior to posterior extremity 25 mm.; height complete 14 mm.

This species is quite common in the sandy flags at various localities seldom however attaining the size which it frequently reaches in the Chemung fauna of New York.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Near Deer Park; National Road 6 miles west of Frostburg; Ellerslie, Pennsylvania, 1508.

Collection.—Maryland Geological Survey.

LEPTODESMA AGASSIZI Hall

Plate LXIII, Figs. 9, 10

Leptodesma agassizi **Hall, 1884, Pal. of N. Y., vol. v, pt. 1, p. 182, pl. lxxxix, figs. 17-19.**

Description.—Shell of medium size, subrhomboidal; body broadly ovate and more erect than in associated species of the genus. Anterior

margin broadly rounded below the byssal sinus; ventral margin regularly curved. Anterior wing short, hardly depressed, obtuse. Posterior wing not extended beyond the body of the shell. Surface with concentric growth lines.

Length 25 mm.; height 22 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Road north of Deer Park Station; Allegany Grove, 2355 ?.

Collection.—Maryland Geological Survey.

LEPTODESMA MEDON Hall

Plate LXIII, Figs. 11-15

Leptodesma medon **Hall, 1884, Pal. of N. Y., vol. v, pt. 1, sec. 1, p. 197, pl. xc, figs, 1-4.**

Description.—" Shell of medium size, subrhomboidal; body broad-ovate, oblique at an angle of about 60° with the hinge-line; length nearly one-third greater than the height; antebyssal margin curving slightly outward, concave at the sinus; basal and posterior margins broadly rounded, passing directly into the wing. Left valve gibbous above, depressed-convex below. Right valve somewhat less convex than the left. The right valve appears to have been somewhat smaller and the base more extended than in the left valve. Hinge-line straight; length a little greater than the height of the shell. Beaks at about the anterior third of the hinge, acute, prominent, arching over the hinge-line. Umbonal region gibbous, descending almost vertically on the posterior, and sloping abruptly on the anterior side. Umbonal angle acute. Anterior end short, separated from the body by a marked sinus; extremity angular, gently rounded below. Wing not defined, broad-triangular, reaching nearly to the posterior end of the body; margin slightly concave; extremity acute. Test thin, marked by concentric striæ, which, on the body of the shell, are crowded into fascicles and assume a distinct regularity in passing over the wing. The hinge shows one or two slender parallel grooves. Three similar specimens of the left have respectively the following dimensions: Length 32, 32 and 33 mm.; height 22, 25 and 23 mm.; and hinge-line 25, 27, and 25 mm. In this species the body of the shell resembles *L. robustum* and *L. potens,* but is less oblique to the

hinge-line, the wing less defined, and its posterior extremity not produced into a spine." Hall, 1884.

The individuals referred to this species present considerable variation in shape as shown by the figures.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road 7 miles west of Frostburg; Oakland-Redhouse Road; Allegany Grove, 2020 common, 2215, 2307, 2325 common.

Collection.—Maryland Geological Survey.

LEPTODESMA NAVIFORME Hall

Plate LXIII, Figs. 16, 17

Leptodesma naviforme **Hall, 1884, Pal. of N. Y., vol. v, pt. 1, sec. 1, p. 200, pl. xxii, fig. 15; pl. xxiii, fig. 1.**

Description.—"Shell below the medium size, rhomboidal; body very oblique, short-ovate; length more than one-third greater than the height; anterior extremity subtruncate; margin curving forward, nearly vertical. Left valve convex below, very gibbous above the middle. Right valve depressed-convex below, gibbous above. Hinge-line straight, more than one-third greater than the height of the shell. Beaks obstuse, situated at the anterior fourth of the hinge-line, prominent, directed slightly forward. Umbonal region gibbous, sloping abruptly into the wing. Anterior end short, acute. Wing large, not distinctly limited, extending almost to the posterior extremity; margins scarcely concave below; extremity produced, acute. Test marked by fine concentric striæ, which are crowded into fascicles at nearly equal intervals, rounded upon the upper part of the body, and subangular on the lower part. The striæ are crowded and lamellose on the anterior; on the posterior slope they make a short abrupt curve, passing over the wing with a gently forward direction and curving backward just below the hinge-line. In the weathered surface of the right valve the concentric undulations are stronger, the postcardinal slope is marked by strong interrupted radii which appear to belong to the intimate structure of the shell. The hinge is marked by a single narrow groove." Hall, 1884.

Length 20 mm.; height 13 mm.

This species is distinguished from all others in the fauna by its faint, radiating striæ, a feature observed also on the specimens from New York. It is confined so far as observed to a single horizon near the base of the Parkhead fauna.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Road 1 mile north of Rocky Run; Williams Road, east of Cumberland, 1393; Williams Road, on Polish Mountain, 1162; National Road, on Polish Mountain, 1196; 2½ miles above mouth of Sideling Hill Creek; National Road west of Tonoloway Ridge.

Collection.—Maryland Geological Survey.

LEPTODESMA LICHAS Hall

Plate LXIII, Figs. 18, 19

Leptodesma lichas Hall, 1884, Pal. of N. Y., vol. v, pt. i, p. 232, pl. xxi, figs. 35-39; pl. xci, figs. 19, 20.

Description.—Shell having proportions similar to those of *L. longispinum* but the umbonal ridge is more conspicuously developed and nearer the hinge, making a shorter cardinal slope and a broader antero-ventral slope, the latter barely depressed by the byssal sinus. The umbo is prominent and overarches on the hinge-line. No extended spine on the posterior extremity.

These shells occur occasionally in association with *L. longispinum* and though smaller than the usual New York examples retain throughout the expression of the species.

Length 30 mm.; height 20 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Deer Park; National Road west of Frostburg; Oakland-Redhouse Road; Town Creek, 3584 common, 3760, 3963, 4631.

Collection.—Maryland Geological Survey.

LEPTODESMA ELONGATUM n. sp.

Plate LXIII, Fig. 20

Description.—Shell large, elongate subrhomboidal; body spatulate, very oblique, length of hinge-line less than one-half length of body. An-

terior margin oblique, curving but slightly below the sulc anterior extremity; ventral margin rounded; posterior mar straight, making a slight angle with anterior margin to which parallel. Left valve convex, point of greatest convexity slight to middle. Umbo obtuse, projecting a little beyond hinge-line extremity large, subangular, its surface concave near point, wards body from which it is separated by a depression whic in depth towards anterior margin. Wing not much longer th extremity, its posterior margins slightly concave. Separated by a depression which becomes deeper near hinge-line.

Length of hinge 22 mm.; length of body 48 mm.

Right valve only observed. This species differs from pre scribed species in its very long narrow body.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Piedmont Road, 2½ miles west of Keyser near top of Chemu berland-Barrelville Road near top of Chemung, 570 feet wes conglomerate.

Collection.—Maryland Geological Survey.

Family AMBONYCHIIDAE

Genus GOSSELLETIA Barrois

GOSSELLETIA sp.

Plate LXIII, Fig. 21

Description.—Shell triangular, body oblique, length less th Anterior margin straight, forming nearly a right angle wit margin at umbo; ventral margin curving to meet posterior mar valve only observed. Its umbo elevated, side flattened, anterior margins abruptly incurved. Hinge-line straight, nearly equalli of shell. Ligamental area wide, striated. Surface not observe

Length 58 mm.; height 48 mm.

The cast of the interior of a single valve only has been observ is not sufficiently well preserved to permit confident specific deter

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Williams Road, on Polish Mountain, 1967.

Collection.—Maryland Geological Survey.

Family PTERIIDAE

Genus ACTINOPTERIA Hall

ACTINOPTERIA cf. EPSILON Hall

Plate LXIV, Fig. 1

Actinopteria epsilon **Hall, 1884, Pal. of N. Y., vol. v, pt. i, p. 122, pl. xxiii, figs. 4-6, 8.**

Description.—Shell rhomboidal with broad, suberect body. Base broadly curved, posterior side abruptly rounded. Hinge-line straight, ear small, wing well developed. Left valve normally convex; right valve depressed. The surface of the former bears distinct, fine radial lines with intercalary additions, all crossed by fine concentric striæ. On the right valve the radial lines are subdued and the concentric striæ more conspicuous.

This is one of many species of *Actinopteria* which appeared in the Ithaca beds of New York and have definite phylogenetic relations with the abundant *A. boydi* of the Hamilton fauna. The occurrence of this type of shell in the Maryland strata is of interest.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Six miles west of Frostburg, Allegany County.

Collection.—Maryland Geological Survey.

ACTINOPTERIA BOYDI (Conrad)

Plate LXIV, Fig. 2

Avicula boydii Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 237, pl. xii, fig. 4.

Avicula quadrula Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 243, pl. xiii, fig. 5.

Actinoptera boydi Hall, 1884, Pal. of N. Y., vol. vi, pt. i, sec. i, p. 113, pl. xix, figs. 2-24.

Actinopteria boydi Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 449, fig. 592.

Actinopteria boydi **Cleland, 1911, Bull. xxi, Geol Survey Wi xxii, figs. 7-8.**

Description.—" Shell of medium size, rhomboidal; body o in proportions, the longitudinal axis forming an angle with t of from 45° to 60°; length varying from nearly equal t greater than the height; margins regularly rounded below, nearly vertical for a short distance in front; postbasal si Valves convex, the right valve a little less convex than the l line straight from the anterior side of the beak to the posteric Beak anterior, acute, prominent, inclined forward, rising abo in the left valve. Umbonal region prominent, subtending an Ear short, oblique, limited by a deep but not sharply del Wing large, triangular, not distinctly separated from the shell; margin concave; extremity acute. In the right valv somewhat more extended, the sulcus not strong, but the by marked; the wing is proportionally larger and usually more acu tremity. Test thick; the left valve, in well-preserved specimen by numerous strong, simple, sharp rays, which are continuo umbo to the margin, with rarely intercalated finer rays; cross lar, sharp, elevated, concentric lamellæ which (in good spe produced into subtubular, spiniform extensions upon the ray growth are seen between the lamellæ. On the wing the ra subdued while the concentric lamellæ are strong. The ear only by the crowded concentric striæ. On the right valve tl obsolete on the body and well marked on the wing, and the la pansions are conspicuous. In some casts they appear as elevated lamellæ. Pallial line extending parallel to the ma shell and terminating in a muscular impression on the post A small muscular impression is also seen just in front of th obscure indications of one or two cardinal teeth. Ligamental row, striated, marked by two or three slender grooves, which a divergent from the hinge-line." Hall, 1884.

Length 20 mm.; height 15 mm.

A single valve has been observed, which is probably of this

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Woodmont, 1067.

Collection.—Maryland Geological Survey.

Genus PTYCHOPTERIA Hall

PTYCHOPTERIA sp.

Description.—A single specimen has been observed, which is too poor to permit specific identification.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Woodmont about 1000 feet altitude.

Collection.—Maryland Geological Survey.

Family MYALINIDAE

Genus PTYCHODESMA Hall and Whitfield

PTYCHODESMA sp.

Description.—A single specimen has been observed which is probably of this genus.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Williams Road, east of Cumberland, 1393.

Collection.—Maryland Geological Survey.

Superfamily TRIGONIACEA

Family TRIGONIIDAE

Genus SCHIZODUS King

SCHIZODUS CHEMUNGENSIS (Conrad) ?

Plate LXIV, Figs. 3-5

Nuculites chemungensis Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 247, pl. xiii, fig. 13.

Schizodus chemungensis Hall, 1885, pal. of N. Y., vol. v, pt. i, sec. ii, p. 453, pl. lxxv, figs. 37-40, 45, 41?.

Schizodus chemungensis Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 482, fig. 642.

Description.—"Shell large, rhomboidal-ovate; length one-fourth greater than the height. Anterior margin broadly rounded, curving into

the basal margin, which is sometimes nearly straight poster
inferior extremity angular. Posterior margin obliquely tru
dinal line straight, less than half the length of the shell.
pressed-convex below, becoming gibbous in the middle and al
usual condition of preservation the shell is very much depress
about the anterior third, prominent. Umbonal slope subang
above, less prominent below. Surface marked by fine conc
of growth, which are partially preserved in the cast. Thre
measure respectively 33, 35, and 43 mm. in length, and 25,
mm. in height. This species resembles *S. appressus* in for
portions and is probably only a variety of that species which
different conditions." Hall, 1885.

The shells referred to this species have a more gibbous un
more convex than the specimens figured by Hall appear to be.
also somewhat smaller in size. They differ from *S. oherni* in b
more transverse, more obliquely truncated behind, umbonal
angular.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMB
Creek, 3496 cf., 3453 abundant, 4631?

Collection.—Maryland Geological Survey.

SCHIZODUS CHEMUNGENSIS VAR. QUADRANGULARIS H

Plate LXIV, Fig. 6

***Cytherodon* (*Schizodus*) *quadrangularis* Hall, 1870, Prelimi
Lamellibr. Shells, pt. ii, p. 96.**

***Schizodus chemungensis* var. *quadranglaris* Hall, 1884, Pal. of N
pt. i, p. 454, pl. lxxv, figs. 31-34, 36.**

***Schizodus quadrangularis* Grabau and Shimer, 1909, N. Amer.
vol. i, p. 482, fig. 642.**

Description.—Shell subrhomboidal, with angles rounded;
central; anterior margin semicircular, posterior sloping and su
postlateral angle due to prominence of umbonal ridge, consp
not acute; posterior slope from the umbonal ridge concave
concave and sloping regularly forward and downward. Surfa

This species is distinguished from allied Devonian forms of the genus by its low umbonal ridge and direction of its posterior margin. It is a well-known Chemung and Ithaca fossil in New York.

Length 25 mm.; height 20 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Near Deer Park Station.

Collection.—Maryland Geological Survey.

SCHIZODUS OHERNI n. sp.

Plate LXIV, Figs. 7-14

Description.—Shell small, varying from rhomboidal to suborbicular, the latter shape more frequent in young shells; length nearly equal or slightly greater than width; hinge-line short, convex. Posterior margin gently curved, descending obliquely to postinferior extremity, or rounded; anterior margin curving to ventral margin; postinferior extremity extended in some individuals, or in other cases but slightly so. Valves convex to gibbous; beaks anterior or nearly subcentral in position, gibbous, elevated above hinge-line, incurved; umbonal slope rounded to angular; surface descending abruptly to postcardinal margin, this portion being convex to concave; convex towards anterior and ventral margins.

Surface smooth, bearing faint concentric striæ. Test thick, especially so near umbo. Interior shows deep anterior and posterior muscular scars, the anterior scar a little higher; right valve bearing two diverging teeth with smooth edges, a slight depression between them; left valve with two corresponding depressions separated by a slightly bifid elevation which appears as a bifid pit beneath beak in casts of interior.

Length 15-17 mm.; height 14-16 mm. in large individuals.

This species is characterized by its strong muscular scars, small size, small umbo neatly incurved over hinge, and oblique shape. The test is quite thick over umbo so that the exterior appears much more gibbous than casts of interior. The shape is quite variable. It has the characteristic hinge of the genus *Schizodus* and is not clearly referable to any previously described species. Specimens occurring at higher horizons are usually somewhat larger than those from the lower horizons.

This species occurs chiefly in conglomeratic sandstones.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBE
Grove, 2662; Williams Road, on Polish Mountain, 2382;
2228 common, 2391, 2496 ?, 3593, 4631; near Pennsylva
state line, west of Tonoloway Ridge near school house in lo
erate zone. Millstone, 2322, 3116 abundant. A smaller fo
of this species, occurs at Town Creek, 3760, 3870. PARKHI
Two miles west of Pawpaw, West Virginia, 1763; Mil
abundant.

Collection.—Maryland Geological Survey.

SCHIZODUS FROSTBERGENSIS n. sp.

Plate LXIV, Fig. 15

Description.—Shell small, elliptical-ovate, length abou
height; hinge-line short. Anterior margin rounded; post
oblique, nearly straight above, abruptly rounded at junction
margin; ventral margin curved. Beaks situated about one
of shell from anterior extremity, small, slightly elevated abo
incurved. Valves convex, somewhat gibbous beneath umbo;
ing regularly towards margins; umbonal slope not angula
Anterior and posterior muscular scars distinct. Surface n
observed, probably smooth.

Length 14 mm.; height 10 mm.

This species is quite distinct from previously described sp
genus in its general expression.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEM
Creek, 3760, 3870.

Collection.—Maryland Geological Survey.

SCHIZODUS TRIGONALIS n. sp.

Plate LXIV, Figs. 16-18

Description.—Shell large, triangular to rhomboidal; equiv
longer than high; hinge-line short. Anterior and poste
slightly curved, oblique; ventral margin curving strongly at

with anterior margin, more abrupt
Beaks subcentral, slightly anterior
incurved over hinge-line. Valve
surface sloping rapidly towards a
and ventral margins. Umbona
show a bifid tooth in right valv
well marked.

Length of larger individual 5

This species differs from
in its nearly central umbo an
somewhat resembles a shell
Hall in the Paleontology of
fig. 41 but its umbonal slo
illustrated in pl. lxiv, fig. 1
outline suggests the genus

Occurrence.—JENNINGS
Creek, 2023, 2228. PA
Mountain, 1352; Millst

Collection.—Maryland

Sı

AVI

Pecten cancellatus
Aviculopecten canc
figs. 12, 14-19

Description.—S
face covered with
delicate cancellati

A single valve
this species.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBE[R]
Road, on Polish Mountain, 1289.

Collection.—Maryland Geological Survey.

AVICULOPECTEN ? sp.

Description.—An imperfect valve which has been obse[rved in the]
Chemung at Allegany Grove is probably referable to this ge[nus]
not been figured.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER
Grove, 1633.

Collection.—Maryland Geological Survey.

Genus LYRIOPECTEN Hall

LYRIOPECTEN TRICOSTATUS (Vanuxem)

Plate LXV, Fig. 1

Avicula tricostata **Vanuxem, 1842, Geol. of N. Y., Rept. 3d Dist.,**
Lyriopecten tricostatus **Hall, 1884, Pal. of N. Y., vol. v, pt. i, fig. 11; pl. vii, fig. 26; pl. x, figs. 6-12.**

Description.—Shell large, subcircular or obliquely broad-
subcentral. Wings relatively small and smooth. Surface
strong simple and distant radial costæ most of which reac[h]
those of the major series being 14-16 in number. These
elevated from the general surface and in the broad flat int
finer striæ usually of two orders, the larger in the middle an
at the sides.

This is a very well-characterized species of the New Yor
fauna. Few examples have been observed in the Maryland

Length 45 mm.; height 45 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER
Altamont Road; Oakland-Redhouse Road; National Road 6 m
Frostburg; 2 miles west of Pawpaw, West Virginia; on coun[t]
top of Jennings, top of Green Ridge.

Collection.—Maryland Geological Survey.

Superfamily MYTILACEA

Family MODIOLOPSIDAE

Genus MODIOMORPHA Hall

MODIOMORPHA SUBANGULATA Hall

Plate LXV, Fig. 2

Modiomorpha subangulata Hall, 1885, Pal. of N. Y., vol. v, pt. i, sec. ii, p. 287, pl. xxxv, figs. 10, 11.

Description.—" Shell of medium size, elongate subovate, wider behind; length more than twice the height, basal margin slightly arcuate, abruptly rounding at the extremities; posterior margin acutely rounded below and obliquely subtruncate to the cardinal line; cardinal margin nearly straight. Anterior end rapidly declining from the beak and abruptly rounded below. Valves moderately convex in the posterior part, and gibbous and subangular in the umbonal region. There is a broad depression or sinus which extends from just posterior to the beak to the basal margin near the middle of the length of the shell. Hinge-line slightly oblique, extending about half the length of the shell. Beaks almost anterior, prominent, small, angular, incurved and elevated above the hinge-line. Umbonal region gibbous, with a prominent ridge extending from the beaks to the postbasal extremity, angular in its upper portion, becoming more subdued toward the posterior end. Test thick, marked by fine concentric striæ, which are sometimes fasciculate, making stronger ridges on the surface. Anterior end marked by a strong, muscular impression just below the beak, close to the anterior margin. A large individual of this species has a length of 55 mm.; and a height of 26 mm. A smaller specimen has a length of 39 mm., ,and a height of 19 mm. This species bears some resemblance to *M. subalata,* but differs in its much stronger and more angular umbonal ridge, which reaches to the postbasal extremity, the basal margin is more arcuate, the cardinal and basal margins are more nearly parallel, and the anterior end is shorter." Hall, 1885.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Williams Road, on Polish Mountain, 2382.

Collection.—Maryland Geological Survey.

Genus GONIOPHORA Phillips

GONIOPHORA HAMILTONENSIS Hall[1]

Plate LXV, Fig. 3

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Road, 1352, 2 miles west of mouth of Town Creek, 1842; T 1679, 1863; 2 miles west of Pawpaw, West Virginia, 1484 c miles above mouth of Sideling Hill Creek. WOODMONT MEM FAUNA. Two miles west of Pawpaw, West Virginia, 1388.

Collection.—Maryland Geological Survey.

GONIOPHORA TRUNCATA Hall

Plate LXV, Figs. 4-6

Goniophora truncata Hall, 1885, Pal. of N. Y., vol. v, pt. 1, sec. xlii, figs. 9, 10; pl. xliv, figs. 1-5.

Goniophora truncata Grabau and Shimer, 1909, N. Amer. Index p. 519, fig. 699.

Description.—"Shell of medium size, trapezoidal; length twice the height; basal margin rounded in the anterior p sinuate a little anterior to the middle and nearly straight or s ing to the postbasal extremity; posterior margin obliquely slightly curving. Cardinal line short, straight. Anterior rounded, limited by an oblique sinus extending from the be convex below the umbonal ridge, gibbous in the umbonal regi above the umbonal ridge is flat or concave, or sometimes a li Beaks anterior, acute and incurved; umbo prominent, angula ridge strongly defined, acutely angular, extending to the p tremity. Test of moderate thickness; entire shell marked by lose, concentric striæ, and that portion of the surface between ridge and the sinus is marked by strong, elevated, radiating dominate the concentric striæ. The test is raised into a cre umbonal ridge, especially in the posterior half of its length muscular impression large and deep, situated close to the ante

[1] For description and synonymy see page 271.

truncated posteriorly by a strong ridge or clavicle. Pallial line parallel to and near the basal margin, appearing as a shallow groove, recurving near the postbasal extremity and terminating in a broad, muscular impression, the anterior margin of which is near the center of the length of the shell. A specimen of medium size is 54 mm. in length and 20 mm. in height. This species is very closely allied to *G. perangulata* of the Schoharie grit, and it is possible that they are identical. In the specimen fig. 3 of plate xl, the hinge-line is shorter than in specimens of *G. perangulata,* but the comparative length of the hinge-line appears to be variable in the two species." Hall, 1885.

This species is distinguished from others in the fauna by its small size, its oblique truncation posteriorly, and very angular posterior umbonal slope. The individuals observed in Maryland seem uniformly smaller than those figured by Hall from New York, and do not show a distinct sulcus in front of umbonal slope.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Williams Road, on Polish Mountain, 1660 common; 2½ miles above mouth of Sideling Hill Creek.

Collection.—Maryland Geological Survey.

GONIOPHORA GLAUCA Hall

Plate LXV, Fig. 7

Sanguinolites glaucus **Hall, 1840, Prelim. Notice Lammellibr., Pt. ii, p. 38.**
Goniophora glaucus **Hall, 1885, Pal. of N. Y., vol. v, pt. i, sec. ii, p. 299, pl. xliii, fig. 16; pl. xliv, figs. 10-17.**

Description.—" Shell large, trapezoidal; length once and a half greater than the height; basal margin gently curved, sometimes scarcely sinuate anterior to the middle; posterior margin obliquely truncate; cardinal line nearly straight or slightly oblique; anterior end declining from the beaks and abruptly rounded below. Valves moderately convex below, sometimes becoming gibbous on the umbonal region. Beaks subanterior, small and closely appressed; umbo prominent; umbonal ridge more or less strongly defined and distinctly angular, extending to the postbasal extremity. Test of moderate thickness, marked by regular, concentric, thread-

like striæ, which are abruptly recurved on the umbonal ri muscular impression deep and strong. The pallial line exten the basal margin, and abruptly recurves over the umbonal rid ing in a large shallow posterior scar upon the cardinal slope. furnished with a strong triangular fold beneath the beak of t and a corresponding depression in the right valve. Thr measure respectively 90, 91, and 49 mm. in length, and 49 mm. in height. This species closely resembles *G. hamil* differs principally in its proportionally shorter form, more margin and more direct umbonal ridge." Hall, 1885.

The individual observed agrees with Hall's figures of New mens save that the posterior extremity is a little more oblique

Occurrence.—JENNINGS FORMATION, PARKHEAD MEM miles southeast of Pratt, on White Sulphur Branch, rare.

Collection.—Maryland Geological Survey.

Order TELEODESMACEA

Superfamily CYPRICARDIACEA

Family PLEUROPHORIDAE

Genus CYPRICARDELLA Hall

CYPRICARDELLA BELLISTRIATA (Conrad) [1]

Plate LXV, Figs. 8-10

This species differs from *C. gregaria* in possessing much s centric striæ which are distinct even in casts of the interioı from *C. marylandica* in being larger, less convex in its pr well as in occurring at a lower horizon. Rather common in tl fauna.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBEI one half miles south of Round, West Virginia; 2 miles north Town Creek, 1642, 1716.

Collection.—Maryland Geological Survey.

[1] For synonymy and description see page 273.

CYPRICARDELLA MARYLANDICA n. sp.

Plate LXV, Figs. 11-15

Description.—Shell considerably larger than *C. nitidula,* subcircular or somewhat obliquely ovate. Beaks anterior; hinge-line gently convex; posterior margin slightly extended and narrowed, rounding somewhat abruptly to the broadly and regularly curved base. The anterior margin is short and inflected beneath the beak, curving outward to the anterior extremity of the shell which lies near the middle transverse axis. Beak depressed; umbo full, regularly convex, surface falling away equally to all margins except toward the hinge where the convexity is carried farther. Faint trace of a depression on the cardinal slope. Surface marked by regular concentric elevated lines which are at times bunched together in groups or festoons with depressed intervals.

This shell has much the aspect of some well-known forms of *Nucula* but though no single specimen displays the hinge in condition for illustration, it is evident from certain impressions that the cardinal structure is that of *Cypricardella.* It differs distinctly in form and contour from any New York species of the genus and approaches most closely its associate *C. nitidula* from which it may be distinguished by its obliquely ovate form and prevailing larger size.

Length 16 mm.; height 15 mm.

The individuals occurring in the upper ferruginous beds of the Chemung are small and depauperate though they seem referable to this species in other respects.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Near Deer Park; National Road west of Frostburg; Oakland-Altamont Road; Town Creek 2496, 3969, 4631.

Collection.—Maryland Geological Survey.

CYPRICARDELLA GREGARIA (Hall)

Plate LXV, Figs. 16-18

Microdon gregarius Hall, 1870, Prelim. Notice Lamellibr., pt. ii, p. 32.

Microdon (*Cypricardella*) *gregarius* Hall, 1884, Pal. of N. Y., vol. v, pt. i, p. 309, pl. lxxiii, figs. 1-6; pl. lxxxiv, figs. 1-4.

CYPRICARDELLA TENUISTRIATA (Hall) [1]

Plate LXVI, Figs. 1-5

The individuals observed in Maryland are somewhat longer proportionally than is usual in the species in New York as shown by Hall's figures. This species is characterized by having strong concentric striæ on umbo. It differs from *C. bellistriata* in having a more acute posterior-inferior angle, weaker striæ save on umbo, and in hinge-tooth. It differs from *C. gregaria,* which it closely resembles, in having much stronger striæ on umbo and also in its proportions.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 2122. PARKHEAD MEMBER. Williams Road, on Polish Mountain, 1660; 2 miles north of mouth of Town Creek, 1716; Town Creek, 1605; 2½ miles above mouth of Sideling Hill Creek; Woodmont, 1285.

Collection.—Maryland Geological Survey.

CYPRICARDELLA NITIDULA n. sp.

Plate LXVI, Figs. 6-12

Description.—Shell rather small, subcircular in outline, slightly truncate on posterior margin, expanding somewhat posteriorly; beak anterior; hinge-line curved. Surface regularly convex, with broad and low but distinct umbonal ridge sloping posteriorly to margin; depressed between umbonal ridge and hinge; covered with regular and, for this genus, strong, rounded and continuous concentric ridges. On internal casts the cardinal area appears broad and subtriangular centrally, extending backward to the posterior extremity of the shell. A deep central socket in the right valve is bounded by low ridges and in the left valve is a strong central tooth with lateral depressions for the reception of the teeth of the other valve. Anterior and posterior muscular scars well defined. Central area more of less decidedly marked by an oblique ridge.

An average specimen has a length of 11 mm. and extreme height of 10 mm.

[1] For synonymy and description see page 275.

This very pretty and well-defined species has the extern
nuculoid but carries the hinge characters of *Cypricardell*
markable development compared with the usual condition i
have been heretofore observed. On this account the speci
than ordinary interest as exemplifying the hinge characte
in which they have not been well understood.

Occurrence.—Jennings Formation, Chemung Member.
of Deer Park Station in buff sandstone, Garrett County;
west of Frostburg.

Collection.—Maryland Geological Survey.

Cypricardella cumberlandiæ n. sp.

Plate LXVI, Fig. 13

Description.—Shell subrhomboidal to subcircular, lengtl
fifth greater than height. Anterior and posterior extremit
ventral and cardinal margins curved, umbo anterior, not
Surface ornamented by strong concentric striæ. Interior unl

Length 26 mm.; height 23 mm.

This species differs from *Cypricardella bellistriata* in beir
cular, less constricted anteriorly and not so distinctly trunc
iorly, umbonal slope less angular. It resembles *C. marylai*
much larger in size, more circular in outline, its anterior
oblique, its concentric striæ coarser. Only two poorly pres
have been observed, which do not seem clearly referable to an
described species.

Occurrence.—Jennings Formation, Chemung Member.
Grove, 2340.

Collection.—Maryland Geological Survey.

Cypricardella crassa n. sp.

Plate LXVI, Figs. 14-20

Description.—Shell small, subrhomboidal, height about e
or eight-ninths length, umbo anterior, cardinal margin formi

angle over umbo. Anterior extremity nearly on a line with middle of length of valve; posterior margin rounding somewhat abruptly to ventral margin. Shell quite convex, umbo full, rounded; surface sloping regullarly from umbo to margins, umbonal ridge rounded, not distinct. Shell massive. Interior shows an oblique tooth in left valve corresponding to a depression in right valve; pallial line distant from margin. Surface ornamented by faint concentric lines.

Length 20-25 mm.; height 16-19 mm.

This species approaches *C. gregaria* but differs in its more massive shell, marked pallial line, more elliptical and less rhomboidal shape, umbonal slope scarcely angular.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Williams Road, on Polish Mountain, 2142 ?; Town Creek, 2122 ?, 2228 ? abundant; Millstone, 2761 abundant.

Collection.—Maryland Geological Survey.

CYPRICARDELLA ? sp.

Description.—Several impressions and exteriors and interiors indicate the presence of another species of this genus of transversely elongate form, with fine concentric surface striations and low postumbonal ridge situated close upon the postlateral slope. The outline of the shells approaches that of *C. tenuistriata* Hall, a Hamilton and Ithaca species in New York, but in the position of the posterior ridge they are distinct. The material obtained is insufficient for final determination.

Length 38 mm.; height 22 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. National Road a few miles west of Frostburg.

Collection.—Maryland Geological Survey.

Genus CYPRICARDINIA Hall

CYPRICARDINIA ELEGANS n. sp.

Plate LXVI, Fig. 21

Description.—Shell of medium size, subrhomboidal elc margin nearly straight, slightly sinuate posterior to mid extremity obliquely truncate, abruptly rounded below; ca nearly straight; anterior end projecting slightly, rounded quite convex near umbo; umbonal slope prominent, ro conspicuous sinus anterior to it. Surface marked by co equally distant lamellose undulations, between which are striæ.

Length 37 mm.; height 15 mm.; thickness 11 mm.

The generic relations of this species are not fully de exterior of one valve only having been observed. The orn that of the genus *Cypricardinia.* The interior of a variety is, however, known. This species closely resembles *C. in* Onondaga and Hamilton of New York. It differs from shape, not being ovate, the posterior end being little wider t ıor end at umbo, while the hinge-line is shorter. It also c mentation. It resembles species of *Goniophora* but the is not so angular as in that genus, while the ornamentation genus to which it is referred.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBE 300 feet west of schoolhouse.

Collection.—Maryland Geological Survey.

CYPRICARDINIA ELEGANS VAR. ANGUSTA n. var.

Plate LXVI, Figs. 22-24

Description.—This variety differs from the typical forn much more angular umbonal slope and in being proportion higher. The cast of the interior shows distinct scars for the anterior adductor muscles and small scars above and post

which probably served for the attachment of the pedal muscles; pallial line distinct; cardinal area deeply striated anteriorly to umbo, striæ curved. A posterior lateral tooth or slender fold is parallel to cardinal margin. The valves are unequal in convexity, a feature not well shown in figure.

Length 50 mm.; height 20 mm.

A larger amount of material may show this to be a distinct species.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 3578, 3584 common.

Collection.—Maryland Geological Survey.

Superfamily LUCINACEA

Family LUCINIDAE

Genus PARACYCLAS Hall

PARACYCLAS MARYLANDICA n. sp.

Plate LXVI, Fig. 25

Description.—Shell of medium size, subcircular; height equal to or slightly greater than length; pallial margin regularly curving from extremities of hinge; cardinal line short. Valves regularly convex, lenticular in shape. Beak slightly anterior to middle, small, appressed, closely incurved, rising but little above hinge-line; umbonal slope limited by a shallow furrow extending to about middle of posterior extremity. Test thin, bearing concentric striæ which are in fascicles at irregular intervals.

Length 25 mm.; height 23-25 mm.

This species closely approaches *P. elliptica* of the Onondaga, differing chiefly in its smaller size, less convexity of valves, umbo slightly less pronounced. It resembles that species so closely, however, that it may be regarded simply as a mutation of that form.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 3770.

Collection.—Maryland Geological Survey.

conspicuous and dominate the revolving striæ. In nearly all the specimens there is a distinct alternation in the strength of the revolving lines, and the finer ones become obsolete." Hall, 1879.

Length 22 mm.; diam. 20 mm.

Excellently preserved and characteristic specimens of this recurrent Hamilton species are present in the Parkhead. It may be readily recognized by its sculpture and by the revolving peripheral band characteristic of this genus.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Rocky Run ?; Town Creek, 1863; 2 miles west of Pawpaw, 1493 common; 2½ miles above mouth of Sideling Hill Creek.

Collection.—Maryland Geological Survey.

PLEUROTOMARIA ? sp.

Description.—A greatly compressed individual found at Ellerslie, Pennsylvania, is doubtfully referred to this genus. It is not sufficiently well preserved to permit illustration.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Ellerslie, Pennsylvania, 1316.

Collection.—Maryland Geological Survey.

Genus MURCHISONIA d'Archiac and de Verneuil

The genus *Murchisonia* was formerly made to contain species of many distinct generic types. Further study of these forms has shown that it is desirable to separate them into a number of distinct genera upon the basis of their exterior ornamentation and internal structure. Two of these genera are present in the Jennings fauna, *Hormotoma* and *Ectomaria.*

MURCHISONIA ? sp.

Description.—A large species of this genus is found with some frequency in the form of external casts but in no instance are the specimens so preserved as to justify an attempt at their identification. These shells attain a length of 50-60 mm. with a basal width of 12-14 mm. and have 7-8 whorls.

Length of largest specimen observed 20-25 mm.; diameter at aperture 6-7 mm.

The genus *Ectomaria* is regarded by Perner as synonymous with the genus *Solenospira* of Ulrich.[1] It closely approaches Hormotoma but differs in having the two revolving peripheral carinæ more widely separated, while there is no true peripheral band between them as in Hormotoma. Again Hormotoma possesses only two revolving carinæ while Ectomaria may have a larger number. This species differs from *E. ecclesiæ* in its much larger size, more rounded volutions and in having 3 or more revolving carinæ.

The specimens figured apparently differ in their apical angles. The medium angle is correct. The drawings were made from squeezes and the apparent differences are imperfections due to this cause.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 2228. PARKHEAD MEMBER. Williams Road, on Polish Mountain, 1660; 2 miles west of Pawpaw, 1493; 2½ miles above mouth of Sideling Hill Creek.

Collection.—Maryland Geological Survey.

ECTOMARIA ECCLESIÆ n. sp.

Plate LXVII, Figs. 9-12

Description.—Shell small, extremely terete. Whorls, at full growth not less than 12, each bearing a prominent slit band with elevated margins, from which the surface of the whorl slopes abruptly above and below, the upper slope being twice the width of the lower. Sutures deep, the whorls thus outstanding prominently and angularly. Surface marked by fine raised concentric lines converging abruptly backward on the upper and lower parts of the whorl to meet the slit band. This ornament is not retained on the casts from the sandstones. Length of average specimen 12 mm., width of body whorl 3 mm.

This species approaches closely *M. micula* Hall from the Hamilton fauna of New York (see Pal. N. Y., vol. v, pt. ii, p. 93, pl. xxi, fig. 11)

[1] Syst. Sil. Boheme, vol. iv, th. ii, p. 133.

BELLEROPHON CLARKI n. sp.

Plate LXVII, Figs. 17-20

Description.—Shell subglobose; diameter of shell about equal to greatest diameter of volution at aperture. Inner volutions small, gradually enlarging to middle of outer volution, from which point it expands rapidly to aperture. Aperture expanded; peristome sinuate in front, slightly auriculate on side. Umbilicus small, apparently open. Surface bearing a distinct dorsal carina and ornamented by regular equidistant fine transverse striæ, which bend backwards in approaching carina over which they pass with a marked retral curvature.

Diameter of shell usually 8-12 mm., diameter of aperture same.

This species approaches *B. mæra* in form but is much smaller and differs in ornamentation. It resembles *B. acutilirata* in ornamentation but is more globose and has a distinct carina. It also resembles *B. pelops* of the Onondaga in some respects. This is a common and characteristic species of the Parkhead, rarely occurring in the Chemung. It is named in honor of Wm. Bullock Clark, State Geologist of Maryland.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Two miles north of mouth of Town Creek, 1949; Town Creek, 2228. PARKHEAD MEMBER. Williams Road, on Polish Mountain, 1660; Town Creek, 1679 abundant, 1851 abundant; 4 miles south of Pratt abundant; 2 miles west of Pawpaw, 1493; Little Orleans; 2½ miles above mouth of Sideling Hill Creek.

Collection.—Maryland Geological Survey.

BELLERPHON cf. CLARKI

Description.—A species of Bellerphon resembling *B. clarki* is found in the Ithaca fauna at Yellow Springs. It differs from *B. clarki* in possessing faint revolving striæ and a somewhat more prominent carina. It is not sufficiently perfect for illustration.

Occurrence.—JENNINGS FORMATION, WOODMONT MEMBER, ITHACA FAUNA. Yellow Springs, West Virginia.

Collection.—Maryland Geological Survey.

parallel to the lines of growth in the shell, and, in the other direction, in diagonal lines crossing these, giving the aspect of a quincunx arrangement. On the removal of the shell the carina on the cast usually extends but a short distance from the margin of the aperture, and the dorsum beyond this is obtusely or obscurely angular." Hall, 1879.

Diameter 20 mm.; diameter aperture 22 mm.

The specimens of this species, which occur in Maryland, are usually smaller than those illustrated by Hall from New York although some are equally large. Casts of the interior appear a little less rotund. The surface ornamentation agrees well with that of the typical forms. Certain poorly preserved specimens occurring in the Ithaca fauna at Millstone appear to be referable to this species, but do not show the pustules on the surface of the shell clearly.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 2391, 2496. PARKHEAD MEMBER. Williams Road, on Polish Mountain, 1660; Town Creek, 1851; 2 miles west of Pawpaw, 1763; Little Orleans; 2½ miles above mouth of Sideling Hill Creek. WOODMONT MEMBER, ITHACA ? FAUNA. Millstone, 1141.

Collection.—Maryland Geological Survey.

Family EUOMPHALIDAE

Genus STRAPAROLLUS Montfort

STRAPAROLLUS MARYLANDICUS n. sp.

Plate LXVII, Figs. 23-25

Description.—Shell depressed, conical, volutions in contact, four or more in number. Volutions slender, cross-section circular; sutures pronounced. Umbilicus very large and deep, exposing all volutions, its diameter much greater than that of volutions. Surface with faint transverse striæ crossing volutions obliquely and somewhat fascicled.

Diameter 20-25 mm.; height 10-13 mm.

This species resembles *S. cyclostomus* Hall of the Devonian of Iowa but differs from that species in its higher spire. Its very large umbilicus distinguishes it from all other species of the fauna.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Williams Road, on Polish Mountain, 1660; 2½ miles above mouth of Sideling Hill Creek.

Collection.—Maryland Geological Survey.

Genus PHANEROTINUS Sowerby

PHANEROTINUS LAXUS (Hall)

Plate LXVII, Fig. 26

Euomphalus laxus **Hall, 1861, Descriptions of New Fossils, p. 26.**

Euomphalus laxus **Hall, 1862, 15th Rept. N. Y. State Cab. Nat. Hist., p. 54, pl. vi, fig. 2.**

Euomphalus (Ecculiomphalus ?) laxus **Hall, 1876, Illustrations Devonian Foss. Gastropoda, pl. xvi.**

Ecculiomphalus comes **Hall, 1879, *Ibid*, pl. xvi.**

Euomphalus laxus **Hall, 1879, Pal. of N. Y., vol. v, pt. ii, p. 60, pl. xvi, figs. 8, 9, 16-18.**

Phanerotinus laxus **Grabau and Shimer, 1909, Index Foss. N. Amer, vol. i, p. 656, fig. 901.**

Description.—" Shell discoid; lower side broadly umbilicate. Volutions about four, nearly in the same plane, the inner ones rising moderately above the plane of the outer one, disjoined throughout their entire extent, very gradually and regularly expanding from the apex; section circular. Aperture (so far as known) subcircular, scarcely expanded. Surface marked by crowded concentric striæ, which are sometimes regular and equal, and on some parts of the shell more closely arranged, and all directed a little forward, from the inner side of the volution." Hall, 1879.

Diameter 25 mm.; diameter of volution at aperture 7 mm.

A single specimen of this species has been observed in the Parkhead of Maryland.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Two and a half miles above mouth of Sideling Hill Creek.

Collection.—Maryland Geological Survey.

Genus EUOMPHALUS Sowerby

EUOMPHALUS TIOGA Hall

Euomphalus tioga **Hall, 1879, Pal. N. Y., vol. v, pt. ii, p. 56, pl. xxvii, fig. 8.**

Description.—" Shell discoid; upper side moderately concave from the dorso-lateral angle; lower side broadly umbilicate, the dorso-basal margin acutely angular. Periphery flattened, oblique to the plane of the shell, and sloping outwards from the upper margin. Volutions probably three or more, gradually enlarging from the apex; the remains of two only are shown in the specimen figured, in which the extremity of the outer volution is much wider than high. Aperture unknown; transverse section triangular, with the inner angle truncated. Surface of the upper side and periphery preserving the remains of striæ, which bend abruptly backwards at the lower carina. The specimen is essentially a cast of the interior, and somewhat worn. The species is extremely similar to the *E. deceui,* with more slender volutions, and the dorso-basal margin more acutely angular." Hall, 1879.

Diameter 140 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Near Little Orleans.

Collection.—Maryland Geological Survey.

Family TURBINIDAE

Genus CYCLONEMA Hall

CYCLONEMA CONCINNUM Hall

Plate LXVII, Figs. 27-29

Cyclonema concinna **Hall, 1876, Illustrations of Devonian Foss. Gastropoda, pl. xii.**

Cyclonema concinna **Hall, 1879, Pal. of N. Y., vol. v, pt. ii, p. 38, pl. xii, figs. 38-40.**

Description.—Shell subglobose, conical; apical angle large; volutions four or more in entire shells; last volution greatly enlarged, ventricose. Surface of upper volutions bearing 3 to 4 delicate, revolving carinæ, two of which are near upper suture; body volution bearing one or two deli-

and but a small or no umbilicus. That author, however, includes species without umbilicus in the former genus.

It seems to the writer that *Polytropus* as defined by Perner may include more than one genus and that the possession of a well-marked umbilicus may probably be regarded as diagnostic of it. The species in question does not have sigmoidal transverse striæ, while it seems to have the small or closed umbilicus of *Cyclonemina* to which it is here referred.

This shell is quite distinct from other species of the genus. It resembles *C. multistriata* but differs in much smaller apical angle, in bearing more distant, stronger, broader carinæ and in being usually larger. It abounds in a stratum near the base of the Chemung at Town Creek.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 2122, 2228 abundant.

Collection.—Maryland Geological Survey.

CYCLONEMINA CRENULISTRIATA var. OBSOLESCENS n. var.

Plate LXVIII, Fig. 5

Description.—This variety differs from the typical form in lacking revolving carinæ on the upper part of the body volution.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Town Creek, 2228.

Collection.—Maryland Geological Survey.

CYCLONEMINA MULTISTRIATA n. sp.

Plate LXVIII, Figs. 6-10

Description.—Shell conical, volutions gradually increasing in diameter to body volution which is ventricose; number of volutions four in ordinarily preserved specimens. Volutions rounded; suture distinct. Aperture oblique. Umbilicus small. Surface ornamented by 20 or more strong revolving carinæ, crossed by fine but distinct transverse striæ, which become stronger on crossing carinæ, making the latter appear as if somewhat nodose.

Length 25 mm.; diameter 22 mm.

Genus LOXONEMA Phillips

LOXONEMA HAMILTONIÆ Hall[1]

Plate LXIX, Figs. 1, 2

This Hamilton species occurs occasionally in the Parkhead member of the Jennings.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Williams Road, on Polish Mountain, 1660.

Collection.—Maryland Geological Survey.

LOXONEMA TEREBRUM Hall

Plate LXIX, Figs. 3-7

Loxonema terebra Hall, 1879, Pal. of N. Y., vol. v, pt. ii, p. 48, pl. xiv, figs. 6, 7.

Loxonema terebra Grabau and Shimer, 1909, Index Foss. N. Amer., vol. i, p. 694, fig. 992.

Description.—Shell elongate; spire rapidly ascending; volutions slightly rounded, bearing strong elevated, obtusely angular and sigmoid-curved surface plications which bend backward a little below the suture and make a more gentle curve forward to the base of the volution.

Height 60 mm.; diameter 16 mm.

Few specimens of this species have been seen whose preservation has permitted the retention of the surface characters though the shell appears to be common at the localities cited. It is also locally abundant in the upper Chemung beds of New York.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Near Green Glade Run; National Road 6½ miles west of Frostburg; Town Creek, 2122, 2228.

Collection.—Maryland Geological Survey.

LOXONEMA STYLIOLUM Hall

Plate LXIX, Figs. 8-10

Loxonema styliola Hall, 1876, Illustrations Devonian Foss. Gastropoda, p. 14.

Loxonema styliola Hall, 1879, Pal. of N. Y., vol. v, pt. ii, p. 48, pl. xiv, figs. 8, 9.

[1] For synonymy and description see page 294.

It does not seem desirable to erect a new genus for the reception of the shells described based upon the materials observed. They are hence referred tentatively to the genus *Loxonema.*

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Oakland-Altamont Road; 2 miles north of mouth of Town Creek, 1949. PARKHEAD MEMBER. Williams Road, on Polish Mountain, 1352, 1660 abundant; 2 miles north of mouth of Town Creek, 1723, 1842 common; 2 miles west of Pawpaw, 1493; Little Orleans, abundant; Fifteenmile Creek, 1 mile above Little Orleans, 1773; 2½ miles above mouth of Sideling Hill Creek.

Collection.—Maryland Geological Survey.

Superfamily TAENIOGLOSSA

Family PURPURINIDAE

Genus TRACHYDOMIA Meek and Worthen

TRACHYDOMIA PRÆCURSOR (Clarke)

Plate LXIX, Figs. 15, 16

Palæotrochus præcursor **Clarke, 1885, Bull. U. S. Geol. Surv., No. 16, p. 55, pl. iii, figs. 6-9.**

Description.—Shell rotund, with short spiral, and broad body whorl. Volutions 5-6. Sutures deeply impressed. Apical angle 50°. Body whorl narrowly flattened at the suture, thence the slope being broad depressed curve to the greatest diameter which is ⅔ the distance across the whorl. Aperture entire, oval, embracing ⅓ of the penultimate volution. Outer lip thin, uninterrupted. Inner lip somewhat thickened; excavate. Shell non-umbilicate.

Surface with revolving rows of subequal tubercles, those adjoining the suture, and at the periphery, being the more prominent. Nine or ten of these rows occur on the body whorl. Very fine concentric lines cross this tubercled surface, and these are more noticeable upon the earlier whorls.

Height 10 mm.; diameter 7 mm.

ton Rowe, a graduate of the John Hopkins University and an assistant on the Geological Survey of Maryland; by him much valuable material employed in the study of the Jennings formation was collected.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Williams Road, Polish Mountain. PARKHEAD MEMBER. Rocky Run cf., Town Creek, 1863 cf., 2½ miles above mouth of Sideling Hill Creek. cf.

HOLOPEA MARYLANDICA n. sp.

Plate LXIX, Figs. 19, 20

Description.—Shell short, rotund, spire short consisting of 4-5 volutions, body whorl projecting well beyond the rest of the spire, but not so extremely ventricose as in many of these species. Whorls all convex and smooth, the upper whorls having an obliquely sloping surface and the body whorl having a vertical width equal to the remaining height of the spire. Sutures deep but not excavate. No concentric surface lines are retained on the external casts. Height of an average specimen 15 mm.; diameter of body whorl 18 mm.

This species is distinguished from its associate *H. rowei* by its lower spire and proportionally broader body whorl.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Williams Road, Polish Mountain.

Collection.—Maryland Geological Survey.

HOLOPEA HUMILIS n. sp.

Plate LXIX, Fig. 21

Description.—Shell very small, depressed subglobose. Spire very small, body volution abruptly enlarging. Volutions three or more; aperture circular; umbilicus not observed. Surface smooth. One specimen shows faint sign of a median revolving carina, rendering reference to *Holopea* uncertain. This feature, however, may be due to condition of preservation.

Height 8 mm.; width 8 mm.

ORTHONYCHIA UNGUICULATA n. sp.

Plate LXX, Figs. 7-9

Description.—Shell conical, curved; apex minute, incurved; volutions about one and one-half. Initial portion of shell often somewhat compressed laterally or even carinate; body volution expanding towards aperture, bearing folds of varying degrees of distinctness. The extent to which the folds are developed is variable, in some specimens being scarcely noticeable, in others pronounced. Aperture subcircular or slightly compressed laterally, oblique, fluted by folds in some shells.

Length of specimen of ordinary size 10-13 mm.; diameter of aperture 6-8 mm. This species differs from ***Platyceras marylandicum*** in its more attenuate apex and smaller size.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Williams Road, on Polish Mountain, 1660 common; 2½ miles above mouth of Sideling Hill Creek.

Collection.—Maryland Geological Survey.

ORTHONYCHIA sp.

Plate LXX, Figs. 10, 11

Description.—A single specimen in the Parkhead fauna differs from the other species observed in increasing less rapidly in diameter toward apex. It resembles *O. unguiculata* but the apex is less attenuate and aperture more plicate than is usual in that species. It resembles ***Platyceras*** *marylandicum* in its plications but increases much less rapidly in diameter, a feature not well shown in the drawings. Larger collections may prove it to be a new species.

Length 12 mm.; diameter aperture 7 mm.

Occurrence.—JENNINGS FORMATION, PARKHEAD MEMBER. Two and one-half miles above mouth of Sideling Hill Creek.

Collection.—Maryland Geological Survey.

anteriorly in passing over sides and posteriorly in passing over dorsal and ventral margins.

Length 28 mm.; greater diameter aperture 22 mm., lesser diameter 9 mm.

This species is quite distinct from any other form known to the author. It may be somewhat distorted, although shells of other species associated with it do not appear to be compressed.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Upper *Tropidoleptus zone,* ? near Pennsylvania-Maryland state line, west of Green Ridge.

Collection.—Maryland Geological Survey.

PLATYCERAS sp.

Description.—Shell curved, very abruptly contracted at apex which is small. Shape of aperture unknown.

This shell appears to be of the type of *P. attenuatum* of the Hamilton of New York. A single specimen only has been seen, which is too imperfect for illustration.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Upper *Tropidoleptus zone* ? near Pennsylvania-Maryland state line west of Green Ridge.

Collection.—Maryland Geological Survey.

Genus DIAPHOROSTOMA Fischer

DIAPHOROSTOMA LINEATAUM (Conrad)

Plate LXX, Figs. 17-19

Platyostoma lineata Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 276, pl. xvii, fig. 7.
Platyostoma lineata Hall, 1876, Illustrations of Devonian Foss., Gastropoda, pl. ix.
Platyostoma lineata Hall, 1879, Pal. of N. Y., vol. v, pt. ii, p. 21, figs. 1-21.
Diaphorostoma lineata Grabau and Shimer, 1909, Index N. Amer. Foss., vol. i, p. 680, fig. 953.

Description.—"Shell subovate, approaching to subglobose. Spire elevated above the body whorl, though varying in degree; in some extreme varieties, on the same plane or below the outer volutions. The

Description.—This is a minute pteropod whose shells, like smooth needle points make spots and patches everywhere through the Genesee of Maryland. No other structure except the form of the flattened shells is evident. In the Genesee of New York these shells entirely compose in places a well-marked limestone layer (Styliola limestone) and again in the argillaceous Naples shales above are accumulated in immense numbers wherever calcareous nodules or nodular layers appear.

Length 3 mm.

Occurrence.—JENNINGS FORMATION, GENESEE MEMBER. Present at all the Maryland outcrops of these strata.

Collection.—Maryland Geological Survey.

Suborder CONULARIDA

Family TENTACULITIDAE

Genus TENTACULITES Schlotheim

TENTACULITES DESCISSUS n. sp.

Plate LXX, Figs. 20-23

Description.—Elongate aculeate cones characterized by differential markings in successive growth stages. The early shell, covering from one-third to one-half the length of the tube, bears subequal and closely appressed annulations. These rings gradually become more widely separated and at intervals coarser and broader annuli occur; finally the spaces between the annuli bear only one or two lesser rings and the entire surface shows very fine concentric lines.

The species is well defined, clearly distinct from the form commonly occurring in the Chemung fauna of New York, *T. spiculus* Hall. The length of a full-grown specimen is 25 mm.

Occurrence.—JENNINGS FORMATION, CHEMUNG MEMBER. Most common in the vicinity of Deer Park, Garrett County; also in the Polish Mountain section, and Green Ridge, Allegany County. National Road west of Frostburg; Oakland-Altamont Road; R. Gordon's farm 1 mile northeast of Mountain Lake Park.

Collection.—Maryland Geological Survey.